UTILIZATION OF AGRICULTURAL GROUP RESIDUES

An Annotated Bibliography of Selected Publications, 1966-76

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ABSTRACT

Y. W. Han and S. K. Smith. Utilization of Agricultural Crop Residues. U.S. Department of Agriculture, Agricultural Research Service, ARS W-53, 120 pp., 1978.

This publication illustrates the great diversity of problems involved in utilizing agricultural crop residues and offers a guide to some of the important investigations in this field. Data were collected from a large number of U.S. and foreign publications to make them more easily available to researchers, farmers, and policymakers of agricultural management. There are 642 titles that were selected from Chemical Abstracts, Biological Abstracts, the National Agricultural Library Catalog (CAIN), and Food Science and Technology Abstracts published from 1966 through 1976. Abstracts were made either from other abstracts or from the original journal articles. Agricultural crop residues, which consist mainly of cellulose, hemicellulose, lignin, pectin, and other plant carbohydrates, can best be utilized as one of the five F's: Fuel, Fiber, Fertilizer, Feed, and Food. These utilization methods are broadly grouped into four categories: (1) Direct uses, (2) mechanical conversions, (3) chemical conversions, and (4) biological conversions.

KEYWORDS: Waste utilization, cellulose, lignin, animal feed, protein, fuel, fiber, food, energy, straw, digestibility, decomposition, nutrition, pollution, compost, fertilizer, furfural, xylitol, ensiling, single cell protein, mulch, soil conditioner, cubing, pelleting

With this issue, the ARS-W series of research reports, published from January 1973 to May 1978 by the Agricultural Research Service--Western Region at Berkeley, Calif. 94705, is discontinued. On January 24, 1978, four U.S. Department of Agriculture (USDA) agencies--Agricultural Research Service (ARS), Cooperative State Research Service (CSRS), Extension Service (ES), and the National Agricultural Library (NAL)--were merged to become a new organization, the Science and Education Administration (SEA) of the USDA. New series are being established by SEA to replace the series being discontinued, and the new series will be sent to existing subscribers.

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE
In Cooperation With
Oregon Agricultural Experiment Station

PREFACE

The purpose of this publication is threefold: (1) To illustrate the great diversity of problems involved in utilizing agricultural crop residues and in abating pollution related to these residues; (2) to serve as a guide to some of the important investigations in the field; and (3) to stimulate new investigations that will eventually solve the problem of effectively recycling the earth's largest renewable resources for the benefit of human beings.

Each year, vast amounts of crop residues are produced (about 60 percent of the total crop production), which have not been effectively utilized because they are bulky and lignocellulosic, thus having little fuel energy per unit volume. Using treated plant residues as animal feeds could result in an ultimate saving of fossil fuel energy and a more effective utilization of products created by the photosynthetic process. Feeding the residues to animals would decrease the pollution potential, but these residues are difficult for even a ruminant animal to digest. If cellulosic wastes produced from cereal grain straws and wood could be utilized, land now used for producing forage and grain could be shifted to food crops for humans.

During the last decade, considerable efforts were made to utilize crop residues. We have collected pertinent data from a large number of U.S. and foreign publications to make them more easily available to researchers, farmers, and policy makers of agricultural management. We selected 642 subject titles from Chemical Abstracts, Biological Abstracts, the National Agricultural Library Catalog (CAIN), and Food Science and Technology Abstracts published from 1966 through 1976. Abstracts were made either from other abstracts or from original journal articles. The abstract source is given for articles written in other than the English language. Known affiliation of a senior author is given to aid direct correspondence.

Agricultural crop residues consist mainly of cellulose, hemicellulose, lignin, pectin, and other plant carbohydrates. The nature of the constituents of these residues can be best utilized as one of the five F's: Fuel, Fiber, Fertilizer, Feed, and Food. This utilization method is broadly grouped into four categories: (1) Direct uses, (2) mechanical conversions, (3) chemical conversions, and (4) biological conversions. Each category is serially divided by type into subgroups--for instance, B1 designates a group of articles related to mechanical conversion for densification and D2, a biological conversion for single-cell protein production. A list of technical abbreviations and author and subject indexes are included to further aid the reader.

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UTILIZATION OF AGRICULTURAL CROP RESIDUES

An Annotated Bibliography of Selected Publications, 1966-76

By Y. W. Han and S. K. Smith[1]

I. TITLES AND ABSTRACTS

A. Direct Uses

1. General Utilization

A1-1 Processing and management of agricultural wastes: Proceedings of the 1974 Cornell agricultural waste management conference. Sixth Cornell Agricultural Waste Management Conference. Dept. Agr. Engin., Cornell Univ., 540 pp. (1974)

These proceedings emphasize information related to Federal effluent guidelines and their effect on the livestock indirectly, control of non-point diffuse pollution sources, and waste stabilization, treatment, and disposal.

A1-2 New sources of food and chemicals; wood, bark, pulp, cellulose. Shafizadeh, F.; Chin. P. S. Proc. Northwest Wood Prod. Clin. 30: 39-52. (1975)

Various sources of cellulosic raw materials and the processes and problems involved in using them are reviewed for future possibilities. Food, chemicals, and fuel are discussed in general terms.

A1-3 Investigation and technical experiences in the recovery of straw black liquor. Lengyel, P. (Paper Res. Devlpmt. Inst., Budapest, Hungary) Proc. Symposium Recovery Pulping Chem., pp. 563-575. (1968)

The recovery of straw black liquor is not as efficient as that of wood black liquors due mostly to the differences in composition between straw and wood. These differences and their influence on the various recovery steps including brown stock washing, evaporation of weak black liquor, combustion of strong black liquor, and causticizing of smelt are discussed.

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A1-4 Fiber materials give plastics new possibilities. Nature copied once again. Lundberg, N. H. (Sentralist. Ind. Forsk. Forskingssveien, Oslo, Norway). Kjemi 30(10A): 35, 37-88, 41. (1970) Chem. Abs. 74 R126544b

A review with no references. Straw, glass fiber, carbon fibers from polyacrylonitrite, rayon (cellulose), or pitch and silicon carbide fiber as plastic reinforcements are discussed.

A1-5 Bleaching of nonwood pulps. McGovern, J. N. (Parsons and Whittemore, Inc., New York, N.Y.) Tappi 50(11): 63A-68A. (1967)

Describes nonwood fibrous material, the bleaching operation, and equipment for the bagasse pulp, bamboo pulp, cotton linters pulp, esparto pulp, reed pulp, rice straw pulp, wheat straw, and the bleaching of different pulps.

A1-6 The role of systems analysis in the use of agricultural wastes by-product utilization and disposal. Schulte, D. D., Kroeker, E. J. J. Environ. Qual. 5(3): 221-226. (1976)

Systems analysis can provide a focal point for cooperation between disciplines working on various aspects of the problem.

A1-7 Cereal straw production and utilization in England and Wales statistics. Staniforth, A. R. Outlook Agr. 8(4): 194-200. (1975)

A number of potential industrial uses for surplus straw in England and Wales are considered and some of the remaining problems are outlined.

A1-8 Composition and nutritive characteristics of low quality cellulosic wastes. Van Soest, P. J., Mertens, D. R. Fed. Proc. 33(8): 1942-1944. (1974)

Discusses the problems associated with feeding low-quality cellulosic waste such as paper to ruminants.

A1-9 Utilization of agricultural wastes. Heald, W. R., Loehr, R. C. Ludington, D. C. (ed.) Agricultural Wastes: Principles and Guidelines for Practical Solutions Symposium. Cornell Univ. Press, Ithaca, N.Y., pp. 121-129. (1971)

Cost information on agricultural waste utilization must be developed. Interdisciplinary approaches are necessary. Uses as a feed supplement and as a fertilizer or soil conditioner offer the greatest opportunities for satisfactory utilization of agricultural wastes in the near future.

A1-10 Review of leaf protein concentrate production and projected uses. Kohler, G. O. U.S. Dept. Agr. Agr. Res. 74(60): 10-17. (1972)

Describes human and animal feeding trials and processes to make leaf protein concentrate from alfalfa.

A1-11 Food from waste. Birch, C. G., et al. Univ. Reading Food Waste Symposium, 301 pp. (1976)

Papers presented at an industry-university cooperation symposium, held at the National College of Food Technology, University of Reading, include: Food From Waste in the Present World Situation; Food From Waste: An Overview; Wastes From Crop Plants as Raw Materials for Conversion by Fungi to Food or Livestock Feed; Yeast From Molasses; The Upgrading of Agricultural Wastes by Thermophilic Fungi; Production of Microbial Protein From Carbohydrate Wastes in Developing Countries; Microbial Production of Oils and Fats, Algal Proteins; Food From Waste Paper; Cultivation of a Thermotolerant Basidiomycete on Various Carbohydrates; Food From Waste: Leaf Protein, Protein From Potato Starch Mill Effluent; The World Food Problem; Nutritional and Toxicological Evaluation of Novel Feed; The Socio-economic Implications of Producing Food From Wastes; and the Bioplex Concept.

A1-12 Agricultural by-products as supplemental feed for crawfish. Goyert, J. C., Avault, J. W., Jr., Rutledge, J. E., Hernandez, T. P. La. State Univ., Baton Rouge. Rpt. No. NOAA-7642105: LSU- R-76-002, 17 pp. (1976)

A study was undertaken to determine how well certain experimental feeds, primarily agricultural plant by-products, would serve as food sources for crawfish culture. In the evaluation process, growth and survival responses were studied using feed sources available to crawfish farmers (sweet potato vines and leaves, sweet potato trimmings, and experimental extruded ration).

A1-13 Recent advances in foliage use muka (feed). Keays, J. L., Barton, G. M. V P X Environ. Canad. Forest. Serv. 137, 94 pp. (1975)

A review with 288 references on the use of leaves of forest trees in animal feeds, cosmetics, and in human and veterinary medicines. Appendixes contain outline of the processing of foliage, biologically active compounds in foliage, and the composition of muka, which is used as a vitamin supplement in feed.

A1-14 The energy plantation. Kemp, C. C., Szego, G. C., Fraser, M. D., Appl. Polymer Symposium 28: 11-19. (1975)

Authors recommend using photosynthesis to fix carbon for energy. Energy plantations can produce fuel at a cost competitive with fossil fuels. Source (sun) is inexhaustible, and the energy can be released with a high degree of thermodynamic availability.

A1-15 Annual fiber crops: a renewable source for cellulose. Miller, D. L. Appl. Polymer Symposium 28: 21-28. (1975)

Annual crops have increasing potential as renewable raw materials to meet future requirements for cellulose and cellulose based chemicals.

A1-16 Biomass energy refineries for production of fuel and fertilizer. Reed, T. B. Appl. Polymer Symposium 28: 1-9. (1975)

If we obtained our supplies of energy, materials, and clean air and water for manufacturing and agriculture by recycling solid waste and sewage, then we would not have shortages of energy, materials, and clean air and water.

A1-17 Agricultural and forest products as sources of cellulose. Stephens, G. R., Heichel, G. H. Wilke, C. R. (ed.) Fifth Biotechnol. and Bio-engin. Symposium. Cellulose as a chemical and energy resource. John Wiley and Sons, New York, pp. 27-42. (1975)

Describes the supply of cellulose from timber, crops, and wastes in the U.S.

A1-18 Utilization of wood as a raw material for the chemical industry. Voss, W. (Fak. Forest., Dessau, Germany) Wiss. L. Techn. Univ. Dresden 17(5): 1405-1413. (1968) Chem. Abs. 71 315215

The conversion of vegetable raw materials, such as straw, wood, and lignite, into products suitable for the chemical industry was investigated by cooking the material in a dilute NaOH solution for a short time at a relatively low temperature, followed by high-pressure hydrogenation in a homogeneous solution.

A1-19 General considerations: Cellulose waste as an economic resource. Bassham, J. A. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. John Wiley and Sons, New York, pp. 9-19. (1975)

Describes the overall energetics of cellulose by green plants and the energy efficiency of this process as it occurs in nature and might occur under optimized conditions. Mentions alternatives for cellulose utilization in the form of a conveniently transportable fuel.

A1-20 Potential useful products from cellulosic materials. Edwards, V. H. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a chemical and energy resource. John Wiley and Sons, New York, pp. 321-338. (1975)

Describes fuels, food and food additives, and organic chemicals manufactured from cellulosics.

A1-21 Nutritive value of corn and sorghum stored by three methods. Harpster, H. W., Long, T. A., Wilson, L. L. Jr. Anim. Sci. 37(1): 368. (1973)

Corn and sorghum were stored, by drying, high moisture, or high moisture treated with 57% acetic acid and 40% proprionic acid methods.

A1-22 Economics of cellulose as a resource. Humphrey, A. E., Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a chemical and energy resource. John Wiley and Sons, New York, pp. 49-66. (1975)

Possible sources of cellulose, chiefly agricultural wastes, are listed. End products can be glucose, SCP, or alcohol.

A1-23 Citrus peel feed. Basile, G. (Chim. -fis., Univ. Messina, Italy) Atti Accad. Peloritana Pericolanti, Cl. Sci. Fis., Mater. Natl. 53: 5-15. (1973) Chem. Abs. 85 122089

Describes a process that combines (1) mincing of the citrus peel residues, (2) addition of 1% $NaOB_2$, and treatment with $Ca(OH)_2$, (3) pressing of the mixture with a Louisville-type press, (4) drying in a triple-pass dryer, (5) cooling, (6) sifting, and (7) packing the finished product.

A1-24 Agricultural wastes. Jewell, W. J., Petersen, J. B., Srinath, E. G., Tseng, W. T., Kroeker, E. J., McGriff, E. C., Jr. J. Water Pollut. Control Fed. 47(6): 1446-1465. (1975)

A review with 161 references.

A1-25 Disposal of black liquors from straw pulping. Karczewska, H. (Inst. Gospodarki Wodnej, Warsaw, Poland) Przem. Chem. 48(5): 293-297. (1969) Chem. Abs. 71 40475f

Alkaline black liquors from straw pulping are used for neutralization of sprucewood-spent sulfite liquors before their alkaline fermentation.

A1-26 Agricultural wastes. McGriff, E. C., Shindala, A. J. Water Pollut. Control Fed. 45(6): 1167-1173. (1973)

The characteristics of agricultural wastes (animal manure) are described; pollution abatement practices are discussed. Types of waste use and reuse are mentioned, such as pyrolysis, biogas production, and refeeding.

A1-27 Some problems and results in cellulose research. Schulz, G. V. Angew. Chem. Int. Ed. England 13(6): 417. (1974) Chem. Abs. 32666f

A review with eight references of problems in molecular weight of native cellulose, structure of its molecule, and fibril arrangement of its chain molecules.

A1-28 Timber, wood residues and wood pulp as sources of cellulose. Stone, R. N. Gaden, E. L., Jr. (ed.) Sixth Bioltechnol. and Bioengin. Symposium. Enzymatic conversion of cellulosic materials. John Wiley and Sons, New York, pp. 223-234. (1976)

Supplies of wood cellulose in the form of wood and bark residues or as waste paper are abundant for use in enzymatic hydrolysis, but will cost 1 to 3¢ per lb.

A1-29 Agricultural residues, including feedlot wastes. Sloneker, J. H. Gaden, E. L., Jr. (ed.) Sixth Biotechnol. and Bioengin. Symposium. Enzymatic conversion of cellulosic materials. John Wiley and Sons, New York, pp. 235-250. (1976)

Primary crop-growing areas in the U.S. are illustrated graphically for several crops. The composition, digestibility, and collection of agricultural wastes are discussed.

A1-30 Emmissions from burning grass stubble and straw. Boubel, R. W., Darley, E. F., Schuck, E. A. (Oregon State Univ., Corvallis, Oreg.) J. Air Pollut. Control Assoc. 19(7): 497-500. (1969)

The emissions from burning the residue following grass-seed harvest were determined by means of a combined laboratory/field study. Complete analyses were determined for the gaseous and particulate emissions for the important grass species from the Willamette Valley of Oregon.

A1-31 Physiocochemical behavior of different celluloses. Lengyel, P., Hajduczky, I. (Papierforsch.-und Entwick-lungsinst. Papirip. Vallalat, Budapest, Hungary) Allg. Pap-Rundschau. 46: 1634, 1636, 1638. (1969) Chem. Abs. 72 68366r

Wheat straw is converted to a hemicellulose, a holocellulose, and two alkali celluloses. These forms of cellulose are characterized by known methods used for determining the colloid-chemical properties of cellulose in the form of suspensions, and sheets. No single method was sufficient for the characterization of the physiocochemical behavior of the celluloses. The various cellulose forms having a different morphology must be characterized separately.

A1-32 Cellulose - A source of future food. Ghose, T. K., Pathak, A. N. (Dept. Chem. Engin., Indian Inst. Technol., New Delhi, India) Indian Chem. Engin. 17(4): 3-16. (1975) Chem. Abs. 85 157857

A review with 31 references on converting cellulose-containing wastes into single-cell protein and to fermentable sugars.

A1-33 Recycling animal waste as feed: a review. Ichhponani, J. S., Lodhi, G. N. (Punjab Agr. Univ., Ludhiana, India) Indian J. Anim. Sci. 46(5): 234-243. (1976) Chem. Abs. 85 175638

A review with 32 references covering poultry, cattle manure, slaughterhouse, cellulosic, vegetable, and fruit wastes, and their potential use as feed sources directly or indirectly.

A1-34 Utilization of nutrient in agro-industrial by-products by swine. Lal, M., Makkar, G. S. Indian J. Anim. Sci. 46(6): 313-318. (1976) Biol. Abs. 63 012362

Twenty-four large white Yorkshire weaners, divided into six groups of comparable weight and equal sex ratio, were offered a weighed amount of six rations composed of various agro-industrial byproducts like rice bran, deoiled rice bran, wheat bran, corn steep fluid, and maize gluten meal, which were adjusted every week for body weight.

A1-35 Agricultural residues and other nonwood plant fibers. Atchison, J. E. Science (Washington, D.C.) 191: 768-772. (1976)

Discusses the increasing potential of nonwood fibers' (grain straws, sugarcane, bagasse, sisal, abaca, jute, kenaf cotton, bamboo, reeds, papyrus, and flaxseed straw) role in paper and allied products for the future.

A1-36 Alternative sources of protein animal feed. Andrews, R. J. Eighth Proc. Nutr. Conf. Feed Mfr., pp. 49-69. (1974)

Discusses fish protein concentrate, soybeans, and SCP from hydrocarbons for the preruminant or veal calf; and SCP from hydrocarbons, field beans (*Vicia faba*), rapeseed, lupins, leaf protein, and nonprotein nitrogen for pigs and poultry.

A1-37 Straw disposal trials at the experimental husbandry farms. Short, J. L. Expt. Husb. 25: 103-136. (1974)

Over an 18-yr period, five methods of disposing of cereal straws were evaluated: Straw removed, farmyard manure applied once every 6 years, for potatoes; straw plowed in after each cereal crop; straw burnt after each cereal crop; and straw removed after each cereal crop. The trials were performed under a six-course arable rotation of potatoes, winter wheat, spring cereal (barley or oats), sugarbeets, and wheat.

A1-38 Protein resources and technology: Status and research needs. Research recommendations and summary. Scrimshaw, N. S., Wang, D. I. C., Milner, M. Synthetic Foods, Natl. Tech. Inform. Serv. U.S. Dept. Com., 6 pp. (1976)

Presents recommendations for research to strengthen U.S. capacity to cope with domestic and export food needs in the future, with an analysis of the factors influencing protein consumption. A discussion of protein resources and the technology to utilize them follows.

A1-39 Waste control and abatement in the processing of sweet potatoes. Smallwood, C., Jr., Whitaker, R. S., Colston, N. V. Synthetic Foods, U.S. Dept. Com., 25 pp. (1976)

The conventional processing of sweet potatoes produces a very strong caustic waste that is high in organic matter. Improved technology is available, such as high-pressure, low-volume water sprays and a dry, caustic peeling process that reduces water use and converts the liquid caustic waste to a semisolid waste that can be disposed of in sanitary landfills or sold as cattle feed. Developing technology offers the potential of lye recovery, an improved steam peel or an infrared dry, caustic peel that increases yield.

A1-40 Crude protein recovery from the potato juice. Sroczynski, A. Synthetic Foods, Natl. Tech. Inform. Serv. U.S. Dept. Com., 33 pp. (1976)

Recovery of crude protein from the potato juice and waste protein water of starch production was investigated.

A1-41 Preparation of stable protein concentrates from grain by-products. Saunders, R. M., Kohler, G. O., Connor, M. A., Edwards, R. H. Synthetic Foods, Natl. Tech. Inform. Serv., U.S. Dept. Com., 10 pp. (1976)

Stable protein concentrates are prepared from wheat millfeed by blending the millfeed with aqueous alkali; separating a juice containing soluble protein and suspended starch and fat; and, coagulating and separating a solid protein concentrate from the separated juice.

2. Fuel

A2-1 Production of gaseous fuel by pyrolysis of municipal solid waste. Crane, T. H., Ringer, H. N., Bridges, D. W. Barber-Coleman Co., Irvine, Calif. Resources Recovery Systems. (1975) Rpt. No. 18: NASA- Cr-141791; 65P NAS9-14305

Pilot plant tests were conducted on a simulated solid waste, which was a mixture of shredded newspaper, wood waste, polyethylene plastics, crushed glass, steel turnings, and water. Tests were conducted at 1400° F in a lead-bath pyrolyser. Cold feed was deaerated by compression and was dropped onto a moving hearth of molten lead before being transported to a sealed storage container. About 80% of the feed's organic to a content was converted to gaseous products, which contain over 90% of the potential waste energy; 12% was converted to water; and 8% remained as partially pyrolyzed char and tars. Nearly half of the carbon in the feed was converted to benzene, toluene, and medium-quality fuel gas. There is a potential credit of over $25 per ton of solid waste. The system was shown to require minimal preprocessing and less sorting than other methods.

A2-2 Systems study of fuels from sugarcane, sweet sorghum, and sugar beets. Lipinsky, E. S., Nathan, R. A., Sheppard, W. J., Lawhon, W. T., Otis, J. L. (Battelle Columbus Laboratories, Ohio. Energy Res. and Devlpmt. Admin.) Rpt. No. 18, 149 pp. (1976)

The primary objective of this study is to suggest methods to derive fuels economically from sugarcane, sugarbeets, and sweet sorghum; to evaluate the potential feasibility of the various suggestions; and to suggest means of converting the potential feasibility into practical feasibility. The sugarcane and sugarbeet productivity per/acre and the production costs are estimated. Sugarcane is suitable for tropical and subtropical climates, whereas the sugarbeet can be grown in temperate climates. The two most promising methods for the thermochemical conversion of the plants into synthesis gas (SNG) are the bailie and the purox process. Anaerobic conversion of sugarcrop fiber into SNG has not been subjected to extensive laboratory investigation, but it is expected that pretreatment would probably be needed to improve the rate of digestion of the lignocellulosic fiber.

A2-3 Synthetic fuels from municipal, industrial, and agricultural wastes (a bibliography with abstracts). Hundemann, A. S., Lehmann, E. J. Natl. Tech. Inform. Serv., Springfield, Va. Rpt. No. 18, 76 pp. (1976)

Research effort directed toward production of gaseous and liquid synthetic fuels from solid wastes was discussed. Waste products used in the syntheses include manure, sewage, paper, and wood. In most citations, methane is the primary fuel produced; however, the production of oils, ammonia, carbon monoxide, and methyl alcohol was also discussed. This updated bibliography contains 71 abstracts, of which 35 are new entries to the previous edition.

A2-4 Coke-making process. Hess, H. U., Cole, E. L. Texaco Devlpmt. Corp. Canad. 975172 (Cl 44-34.) 30Scp 1975 Appl. 123,491 14 Jan. 1972, 11 pp.

Solid organic wastes are slurried with water; the slurry is heated to 550° F at 1000 p.s.i. to form coke particles; a heat sensitive binder is added and the mix is briquetted or pelletized. Wastes like straw can thus be converted to fuel coke.

A2-5 Carbonaceous solid fuel. Momose, K., Miyoshi, J., Sakoda, A. (Matsushita Electrical Industrial Co., Ltd.) Japan 74 01924. (C1C 101) 17 Jan. 1974. Appl. 70 40,725 11 May 1970, 1 p. Chem. Abs. 81 93904h

A briquet with high mechanical strength and resistance to crumbling is produced by binding together a mixture of carbonaceous materials (by-products from processing of hemp straw and tobacco). The binder is CM cellulose crosslinked by Pb salts ($PbNO_3$, $Pb(Me\ CO_2)_2$, $PbCl_2$) that also serve as combustion-improving agents.

A2-6 Industrial pyrolysis of cellulosic materials wood chemistry. Shafizadeh, F. Appl. Polymer Symposium 28: 153-174. (1975)

Describes industrial pyrolysis of cellulosic materials to various fuels and chemicals. Also describes the complex reactions involved, and how they can be controlled to provide acceptable yields.

A2-7 Fuel gas production from solid waste. Wise, D. L., Sadek, S. E., Kispert, R. G., Anderson, L. C., Walker, D. H. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium, pp. 25-27. John Wiley and Sons, New York. (1975)

Describes bioconversion of solid waste (where organic matter is mostly cellulose) to methane.

A2-8 Pyrolysis of organic wastes. Barrett, D. Kirov, N. Y. (ed.) Waste management, control, recovery and reuse. Internatl. Ed. 1974 Australian Conf., Sydney, Austral. Ann Arbor Science Publishers, Inc., Ann Arbor, Mich. (1975)

Organic wastes were split into solid, liquid, and gaseous byproducts by pyrolysis. A batch-type reactor with a paddle stirrer was used, and organic material was introduced after the reactor had reached operating temperature. The recovery train consisted of a cylindrical knockout pot which caught the bulk of the liquor and fines. A tar-mist trap and gas collection system were also included. Cellulosic wastes were pyrolyzed at 600° C. The conditions simulated fluidized bed conditions.

A2-9 Initial pyrolysis of celluloses. Davidson, H. W., Losty, H. H. W. (General Electric Co., Ltd., Wembley, England) Second Conf. Indus. Carbon Graphite Papers, London, pp. 20-27. (1965) Disc. pp. 27-28. (Pub. 1966) Chem. Abs. 66 3964r

A compacted wheat-straw cellulose was carbonized *in vacuo* and in compressed gases. Weight-loss and gas-evolution measurements were made at constant temperature, at constant rate of rise of temperature, and by step-wise heating.

A2-10 An evaluation of methane production from solid waste. Kispert, R. G., Sadek, S. E., Wise, D. L. J. Wash. Acad. Sci. 66(1): 245-255. (1976)

Anaerobic digestion of the organic portion of municipal waste (mostly cellulose) can return the energy value of refuse in the form of pipeline-quality gas, at an acceptable cost.

A2-11 Energy potential from agricultural field residues. Green, F. L. Amer. Nuclear Soc. Trans. 21, 147 pp. (1975)

Lists the feasibility of nonfood (fuel) uses for agricultural residues. The energy value in the residues in 1973 was 50% of the heating value of the coal produced in 1973. If the residues are included, the energy yield to input ratio is 10:1, which is approximately the same as that for petroleum when the energy costs for pumping, refining, and transporting are included.

A2-12 Solid waste conversion: Cellulose liquefaction. Kaufman, J. A., Weiss, A. H. (Dept. Chem. Engin., Worcester Polytech. Inst., Worcester, Mass.) Rpt. No. EPA-67012-75-031. (1975)

This report provides an extensive survey of the state-of-the-art in cellulose liquefaction and its chemistry. The process concept is detailed and related to pyrolysis.

3. Mulch, Fertilizer, Soil Conditioner

A3-1 Interpretation of the water and mineral nitrogen profiles in bare or straw covered parcels of land, using a mathematical model. Muller, J., Brun, F. Bul. Assoc. Fr. Etud. Sol. 5: 25-31. (1970) Biol. Abs. 53 063900

Equations of diffusion were applied to water movement in the soil in order to interpret humidity variations as a function of depth and maximum humidity. The relationship giving the humidity as a function of depth x has a relationship in the form: h = H (1--e--px) in which p represents the probability of water film rupture.

A3-2 The influence of straw cover on the radiation balance of the soil. Hoyningen-Huene, J. V. Agr. Met. 9(1-2): 63-75. (1971)

The effect of a straw mulch on the components of the radiation and on the total net radiation of the soil surface was investigated. The radiation measurements were made from November 1968 to July 1969 above a bare, loamy sand and above a layer of straw (wheat; 0.7 kg/m^2) that was spread out in November 1968.

A3-3 Effect of plowing under of various forms of straw on soil productivity. Ivanov, P. K., Semenova, A. B., Danilov, A. N. Agrokhimiya 6: 55-60. (1971) Biol. Abs. 53 034491

Plowing under wheat, rye, millet, and pea straw increased nitrate and phosphate contents in the soil.

A3-4 Influence of mulch on post harvest soil temperatures and subsequent regrowth of alfalfa *Medicago sativa*. Evenson, P. D., Rumbaugh, M. D. Agron. J. 64(2): 154-157. (1972)

A study was initiated to evaluate the influence of postharvest soil temperatures on alfalfa (*M. sativa*) regrowth. Wheat (*Triticum aestivum*) straw was applied to alfalfa to reduce soil temperature in a variety trial following the second harvest in 1968.

A3-5 The effect of plowing under corn straw on some soil properties and the yield of corn under conditions of dry farming and irrigation. Javanovic, R., Maksimovic, P., Franic, I. Arh. Poljopr. Nauke. 25(89): 39-48. (1972) Biol. Abs. 55 017579

Two factorial trials were set up according to the split-plot scheme in the following combinations: a) corn straw removed, b) corn straw plowed under. The four-line hybrid 'Zemun Polje 755' was used. Plowing was done in October to a depth of 30 cm. Soil samples were taken dirctly after autumn plowing, in the spring during the first 10 days of April, and after harvesting the corn during the second half of October.

A3-6 Phosphorus and nitrate nitrogen immobilization by wheat straw. Black, A. L., Reitz, L. L. Agron. J. 64(6): 782-785. (1972)

Wheat straw was incubated with four soils--Tally loamy sand, Dooley sandy loam, Williams clay loam, and Cherry silty clay. Straw was added at rates up to 10,000 p.p.m.; and P, up to 260 p.p.m. The experiment was a ramdomized complete factorial design with three replications for soils, P rates, and straw rates. $NaHCO_3$-soluble P and nitrates were determined after seven alternate wet and dry incubation periods during a 60-day period.

A3-7 Possibility of using hydrolyzed lignin as an organic fertilizer in sandy soils. Yushkevich, I. A., Titavyi, V. A., Shnyrikov, V. G. (U.S.S.R.) Pochvoved. Agrokhim. 12: 149-153. (1975) Chem. Abs. 85 092819

Hydrolyzed lignin had no negative effect, but lignin detrimentally affected potato growth when applied with NH_4OH or lime.

A3-8 Straw placement: Its effect on nitrification of anhydrous ammonia. Cochran, V. L., Koehler, F. E., Papendick, R. I., (Dept. Agron. Soils, Wash. State Univ., Pullman, Wash.) Agron. J. 67(4): 537-540. (1975)

Gaseous NH_3 was line injected into Walla Walla silt loam at 15-cm depth field application into soil without straw, with the equivalent of 13.5 metric tons/ha of straw applied in a band at the 15-cm depth; and with straw, mixed uniformly in the surface 15 cm of soil. The NH_3 retention zone was sampled periodically for 10 weeks and analyzed for NH_4^--N, NO_2^--N, NO_3^--N, and soil pH. Air samples were withdrawn periodically from the soil systems for determining CO_2 and O_2.

A3-9 Soil surface roughness and straw mulch for maximum beneficial use of rainfall by corn on a blackland soil. Myhre, D. L., Sanford, J. O. Soil Sci. 114(5): 373-379. (1972)

The purpose of this study was to test the hypothesis that a straw mulch on a rough soil surface will increase water intake and storage of rainfall for plant use by corn on a blackland soil. Hypothesis was confirmed.

B. Mechanical Conversions

1. Cubing, Pelleting, Grinding, Dehydration

B1-1 Primary treatment of potato processing wastes with by-product feed recovery. Grames, L. M., Kueneman, R. W. J. Water Pollut. Control Fed. 41(7): 1358-1367. (1969)

Discusses a pilot plant treatment scheme with grease removal unit, a potato waste clarifier, and a belt-type vacuum filter. Organic loading and suspended solids averaged 1,750 and 2,600 mg/l with a population equivalent from the average plant of 200,000. Flume and waste waters had a solids content of 20,000 mg/l, and an overflow rate of 24.5 $m^2/day/m^2$ was used in clarifier for 60% organic and 90% suspended solids. Dewatered sludge (14% dry solids) was sold as cattle feed.

B1-2 Use of straw in the composition of granulated straw-grain mixtures. Bogdanov, G. A., Bugaev, A. A., Shevchenko, N. K. (Nauch.-Issled. Inst. Zhivotnovod. Lesostepi Oles'y A. Kharkov, U.S.S.R.) Fiziol.-Biokhim. Obosnovanie Normirovaniya Energy Pitan. Vysokoproduktivnykh Zhivotn., Tezisy Dokl. Vses. Konf., pp. 12-14. (1975) Chem. Abs. 85 092680

A ration containing 45% wheat straw was treated with 20% NaOH, 25% NH_3, or mixed with 10 kg/T $(NH_4)_2CO_3$. Weight gain increased compared with animals that were fed untreated rations. Proprionic acid in rumen was 1.4 to 1.7 fold higher, which might increase N metabolism and thus productivity of animals.

B1-3 Grind and level of rice straw in finishing rations. White, T. W., Hembry, F. G. J. Anim. Sci. 32(2): 396. (1971)

Rations containing 5 and 20% rice straw were compared to an all-concentrate ration. Average daily gain and carcass weight were highest on 20% rice straw ration.

B1-4 Effects of chopping, pelleting, hydroxide treatment and NPN (non-protein nitrogen) sources on ryegrass straw utilization by heifers. Shultz, T. A., Ralston, A. T. Proc. West. Sect. Amer. Soc. Anim. Sci. 24: 404-408. (1973)

Improved weight gains and increased rumen volatile fatty-acids levels were more pronounced when cattle were fed rations of pelleted hydroxide-treated ryegrass straw containing urea as opposed to biuret.

B1-5 Feed briquets with different amounts of straw for fattening animals (Steers). Davydenko, V. K., Lazarev, I. U. P., Titov, A. M. Vestin S-Kh Nauki (Moscow) 9: 39-44. (1975)

Feeding briquets containing up to 30% rye straw and up to 30% protein in the form of carbamide to young bulls had a favorable effect on their physiological state and performance.

B1-6 Barley straw in pelleted diets for steers. Weisenburger, R. D., Mathison, G. W. Fifty-fifth Ann. Feed Day Rpt., Alberta Univ. Dept. Anim. Sci., pp. 3-4. (1976)

Complete pelleted diets containing 40, 55, and 70% barley straw were individually fed to 18 steers. The more straw was eaten, the worse the daily gain, feed conversion, and dressing percentages.

B1-7 Characterization of straw pellets: Six digestibility studies on wheat straw pellets. Bergner, H., Zimmer, H. J., Muenchow, H. (Sekt. Tierprod. Veterinaermed., Humboldt Univ., Berlin, East Germany) Arch. Tierernaehr. 24(9-10): 689-700. (1974) Chem. Abs. 83 007955

Digestibility and intake trials were carried out on wethers to test six types of straw pellets: unsupplemented pellets, pellets supplemented with NH_4HCO_3 and prepared at a low pressure, pellets supplemented with urea, pellets supplemented with extracted sugarbeet slices, pellets supplemented with extracted sugarbeet slices and urea, and the original wheat straw (all fed as the sole food).

B1-8 Characterization of straw pellets. 8. Changes in straw lignin as produced by the action of ammonia. Mueller, J., Bergner, H. Sekt. Tierprod. Veterinaermed., Arch. Tierernaehr. 25(1): 37-45. (1975) Chem. Abs. 83 077222

Ammoniation of straw decreased the lignin content and improved feed value. Treatment of wheat straw with 10% NH_4OH for 5 hr at 150° C reduced the lignin content by 51%. Part of the lignin was converted to a H_2O-soluble form that could be precipitated by addition of HCl. Pelleting straw with NH_4HCO_3 had the same results to a lesser extent.

B1-9 Lignin, I. Effect of the grinding fineness and drying temperature of samples on lignin yield. Martillotti, F., Valentini, G. (First Sper. Zootec., Rome, Italy) First Ann. Sper. Zootec. 6(2): 151-166. (1973) Chem. Abs. 82 168922

Samples of green alfalfa and Egyptian clover (mainly stalks), grain-free corn silage, hay from permanent meadows, wheat straw, and olivestones were arranged in a factorial design based on two grades of fineness--0.5-1 mm and .355 mm, and two temperatures of drying--40° C for 48 hr and 100° C for 24 hr, on samples previously dried at 40° C.

B1-10 Characterization of straw pellets. 5. Preparation and chemical analysis of wheat straw pellets. Zimmer, H. J., Bergner, H., Marienburg, J. (Sekt. Tierprod. Veterinaermed. Humboldt univ., Berlin, East Germany) Arch. Tierernaehr. 24(9-10): 681-688. (1974) Chem. Abs. 82 154022

Six types of straw pellets were prepared from uniform wheat straw material under practical production conditions and were supplemented with different additives. All types of straw pellets and the original wheat straw material were analyzed for their content of crude nutrients, cellulose, pentosans, readily soluble carbohydrates, and lignin.

B1-11 Studies on the characterization of straw pellets. 1. Asseesment of the effects of chemical degradation in animal experiments. Bergner, H., Marienburg, J. Arch. Tierernaehr. 23(5): 423-434. (1973) Chem. Abs. 80 587475

Mixed pellets of urea and straw that had been pelleted at 80° C after addition of 10% extracted sugarbeet chips and 15% crushed cereals, were tested in experiments on sheep.

B1-12 Effects of pressure treatment upon nutrients in bagasse. Campbell, C. M., Wayman, O., Stanley, R. W., Kamstra, L. D., Olbrick, S., Ho-A, E. B., Kohler, G. O., Walker, H. G., Graham, R. J. Anim. Sci. 36(6): 1199-1200. (1973)

The nutrient digestibility by sheep of rations containing 37 to 40% sugarcane bagasse was increased by previous heat and pressure treatment of the bagasse.

B1-13 Kinetics and mechanism of the thermal degradation of cellulose. Fung, D. P. C. Tappi 52(2): 319-321. (1969) Biol. Abs. 51 051563

The thermal degradation of cellulose has been studied in vacuum 200, 225, 250, and 280° C. A nitration method was used to determine the intrinsic viscosity of the pyrolyzate.

B1-14 Shrinkage of the hydrolyzed material during the percolation hydrolysis. Korol'kov, I. K., Papashnikov, L. M. Sb. Tr., Gos. Nauch. Issled. Inst. Gidroliz. Sul'fitno-Spirt. Prom. 15: 35-42. (1966) Chem. Abs. 67 918085

The loading density of the raw material and the character of its shrinkage during hydrolysis are important factors affecting the yield of sugars, as they determine the volume of the liquid in the hydrolysis apparatus, the frequency of liquid exchange during percolation, and hence the time of retention of sugars in the reaction zone. Shrinkage curves (weight of the raw material as function of the extent of hydrolysis) are presented for wood, sawmill dust, corncobs, sunflower husks, wheat straw, and reeds.

B1-15 Drier for stalky and fibrous materials. Novak, F., Novak, J. Czech. 119,475 (ClF 26b, A 01f), Aug. 30, 3 pp. (1963) Chem. Abs. 67 P3963K

Stalky and fibrous material spread over a flat or roofshaped perforated surface receives direct heat radiation from the walls of a heating channel running underneath. The drying effect is increased by vertical passage of the hot medium through the material.

B1-16 Toxicologic investigation of the dust produced by chipping units for annual plants in the pulp industry. Petrescu, N., Lanfirescu, M., Toba, Gh. Celluloza Hirtie (Bucharest) 15(16): 232-239. (1966) Chem. Abs. 65 15970c

The atmospheric concentration, size distribution, and composition of dust from straw and reed chipping units were investigated.

2. Pulping, fiber, construction materials

B2-1 The future of wood cellulose in textile and plastics applications. Hergert, H. 1. Appl. Polymer Symposium 28: 61-69. (1975)

A review with nine references.

B2-2 Rapid continuous pulping method. Osanov, B. N. L. P. Zherebov, Sb. (Moscow: Lesn. Prom.) pp. 28-54. (1965) Chem. Abs. 65 15654b

The Zherebov method, discussed in the paper, consists of a short-time action of chemical reagents on cellulose-containing raw material in a vertical single-tube digester fed continuously in an upward direction. Data are given on the applicability of the method for pinewood, straw, and reed pulping.

B2-3 Properties of semichemical pulps beaten in different apparatus. Vamos, G., Mero, T. (Paper Res. Inst., Budapest, Hungary) Papiripar Magy. Graf. 9(6): 215-221. (1965) Chem. Abs. 65 13942g

The authors investigated the suitability of domestic raw materials for corrugated-board production. Poplar, hornbeam, and wheat straw were cooked by the neutral sulfite semichemical process to a 70% yield and beaten in a Jokro mill (6 and 8% consistency), in a Sprout-Waldron disk refiner, and in a Valley beater. Beating time, drainage time, fiber length, burst, tear, ring crush, stiffness, and bulk were compared.

B2-4 Paper making with synthetic fibers. IV. Vicsose rayon paper for calligraphy. Macheda, S., Nishikori, S., Ueno, T. Kami-pa Gikiyoshi 17(2): 108-110. (1963) Chem. Abs. 63 5890c

Handmade paper for calligraphy was made by blending stable fiber of viscose rayon and straw pulp, and dispersing the blend in water. The quality of India ink absorbtivity by the straw paper is improved by the blending of viscose rayon fiber.

B2-5 Fibreboard from exotic raw materials. I. Hardboard from rice straw pulps. Mobarak, F., Nada, A. M., Fahmy, Y. J. Appl. Chem. Biotechnol. 25(9): 653-658. (1975) Chem. Abs. 84 75978t

Hardboard was manufactured from rice-straw pulp obtained by both the mechanical and semichemical pulping methods.

B2-6 Treatment of plant fiber material containing inhibitors for setting of cement. Munz, M., Simunic, B. Germ. 1,969,395 (Cl. C. 046) 20 Aug. (1970) 6 pp. Chem. Abs. 73 123263c

A suitable aggregate for the production of a lightweight building material containing 400 kg/m^3 cement and having a weight <650 kg/m^3 is obtained by the treatment of vegetable matter with 10 to 30% cement and a CO_2-enriched air current heated up to 90° C in such a way that at least 60% of the total water of the mixture is removed in 48 hr.

B2-7 Pulp for the Indian paper industry. Muthoo, H. K. Indian Pulp Paper 29(2): 207-222. (1966) Chem. Abs. 64 5289h

The more important fibers now used in papermaking such as rice straw, bamboo, jute sticks, sabu grass, bagasse are described, and their pulping processes are outlined.

B2-8 Feeding of a continuous digester for the pulping of cereal straw. Niwinski, T. Przeglad Papier 21(2): 47-50. (1965) Chem. Abs. 63 785a

Stability of process conditions necessary to obtain a uniform product when pulping straw by a continuous process in a digester was achieved by controlling the pulping variables such as liquor, straw ratio, straw-to-chemicals ratio, temperature, pressure, and cooking time.

B2-9 Straw chaff molding. Ohtsuka, M., Uchihara, S. Japan 73,22,346 (Cl B 29 j) 28 May 1970, 4 pp. Chem. Abs. 80 P84378s

Vinyl monomer-impregnated chaff and rice straw layers were molded to give laminates that are useful as construction materials.

B2-10 New type of panels from organic raw material. Otlivanchik, A. N., Meronov, V. P., Demakina, G. D. (U.S.S.R.) Derevoobrab. Prom. 17(8) 5-6. (1968) Chem. Abs. 70 12778t

The binderless particleboards named Vibrolit were produced on a pilot plant scale from agricultural residues such as straw, cotton stalks, and wood wastes.

B2-11 Effect of sulfidity in the sulfate pulping of reed and wheat straw under rapid cooking conditions. Popovici, M., Constantinescu, O. Celluloza Hirtie 14(7-8-9-): 421-430. (1965) Chem. Abs. 64 5287a

For wheat straw and reed pulping a 15% sulfidity of the cooking liquor, addition of 14% Na_2 as alkali and cooking wheat straw at 165° C for 15 to 20 min is recommended.

B2-12 Manufacture of wheat straw pulp by the ammonium sulfite process. Sato, J., Shimoda, I. Sen-i Gakkarishi 19(1): 34-42. (1963) Chem. Abs. 62 13378b

Semichemical pulp was manufactured from wheat straw by cooking with $(NH_4)_2SO_3$ at pH 9 and 3. The resulting pulps were analyzed, and the mechanical strength of their sheets was measured.

B2-13 Hydroptropic cooking of plants. Schwenzon, K. Zellstoff Papier 14(7): 199-201. (1965) Chem. Abs. 63 16601b

Finely divided wood or straw (4-5 g) was covered with 100 ml ethylene glycol in which 1 to 3 g salicylic acid was dissolved. The container was covered, heated for 1 to 6 hr at 160° to 170° C. Poplar was best; rice straw was poorest.

B2-14 Pulp preparation from wheat stems and cane residues by basic hydrolysis at atmospheric pressure or alkali chlorine treatment. I. Hydrolysis of wheat stems and cane residues at atmospheric pressure. Sun, C. F., T'ang, H. M., Chao, P., Ch'ang, F. M., Chang, T. C., K'o, C. K. Hsueh Yuan Ying Yung Hua Hsueh Yen Chiu So Chi K'an 7: 54-58. (1962)

Wheat stems and cane residues were hydrolyzed in 3% H_2SO_4 at 99.5° C and 1 atmosphere for 240 min. Maximum xylose content in wheat stems was 19.1 g/l and 7% furfural.

B2-15 II. Preparation of viscose pulp by basic hydrolysis at atmospheric pressure. Sun, C. F., T'ang, H. M., Chao, P., Ch'ang, F. M., Chang, T. C., K'o, C. K. Hsueh Yuan Ying Yung Hua Hsueh Yen Chiu So Chi K'an 7: 59-61. (1962)

After hydrolysis as above in B2-14, the sediment was treated with 20 to 30% NaOH at 160° to 170° C and repeatedly bleached with Cl to obtain viscose pulp. Total volume of Cl was about 35%.

B2-16 Pulp preparation by alkali chlorine treatment at atmospheric pressure. Sun, C. F., T'ang, H. M., Chao, P., Ch'ang, F. M., Chang, T. C., K'o, C. K. Hsueh Yuan Ying Yung Hua Hsueh Yen Chiu So Chi K'an 7: 62-64. (1962)

Wheat straw or cane residue pulp was similar to other pulp composition. Fibers obtained after spinning were comparable to other fibers.

B2-17 Easy bleaching pulp from rice straw. Talivar, K. K., Batreja, M. N. Indian Pulp Paper 18(12): 619-622, 698. (1964)

The straw at 5% consistency was treated 0.5 hr at 97° C in open stainless steel vessels with 12% aqueous NaOH. The pulp could be bleached in three stages with a total consumption of 6% Cl.

B2-18 How rice and wheat straw are pulped in the Kocani mill in Yugoslavia. Viola, G. Paper Trade J. 150(24): 74-76. (1966)

Straw is pulped in a two-stage system by using 25 g NaOH/l. in the first stage for 2 hr at 115-125° C and 4-4.5% Cl at 25-30% consistency in the second stage. Two-stage bleaching with hypochlorite completes the processing.

B2-19 Obtaining monosulfite pulp from rice straw in a Pandia continuous digester. Constantinescu, O., Savineanu, C. Celluloza Hirtie 14(6): 219-226. (1965) Chem. Abs. 64 12948a

The authors found that the above process was not economical.

B2-20 Making clay bricks with straw fibers to decrease drying cracks. Conway, E. V. (Redland Bricks, Ltd.) Brit. 1,149,487 (cl. C 04b) 23 Apr. 1969 Chem. Abs. 71 P15713p

Straw is added to clay mixture (in amounts of 20-30 lb/64 ft^3 of clay mixture) to reinforce the pressed green shapes and to provide channels through which moisture can migrate to the surface without internal steam pressure, thus preventing drying cracks which become fractures when fired. Procedure is described and results are given.

B2-21 The manufacture of straw pulp for chemical processing. Dolgov, K. A., Tsarenko, I. M. Bumazhn. i Derevoobrabatyvayuschaya Prom. Inform. Nauch.-Tekh. Sb. 4: 48-50. (1965) Chem. Abs. 65 12403d

Pulp dissolved from rye straw was manufactured by the HNO_3 process. It was bleached by a multistage process, including chlorination, NaClO bleaching, alkali refining, second bleaching, and washing with distilled H_2O between stages.

B2-22 A study of pulp-suspension dewatering and handsheet strength. Gaevskii, B. A. Khim. Pererabotka Drevesiny, Ref. Inform. No. 12, pp. 5-6. (1965) Chem. Abs. 65 7445c

The following pulps were studied: Unbleached sulfite from the Kama pulp and paper mill, unbleached sulfite, bleached and unbleached straw pulps from Poninka pulp and paper mill, and laboratory pulps prepared by soda and HNO_3 processes. A relationship was established between the degree of beating and dewatering time.

B2-23 Pulp-suspension dewatering. Gaevskii, B. A., Dolgov, K. A. Bumazhn. i Derevoobrabatyvayushchaya Prom., Inform. Nauch.-Tekh. Sb. 2: 35-39. (1965) Chem. Abs. 65 2464d

To characterize pulps during beating, a method for determining the dewatering rate is suggested, based on measurements of filtration time at a constant pressure, filtrate volume, suspension temperature, and consistency.

B2-24 Pilot plant production of white printing papers from rice straw. Guha, S. R. D., Mathur, G. M., Sharma, Y. K. Indian Pulp Paper 19(8): 499-501. (1965)

Rice straw gives bleachable pulps under mild cooking conditions.

B2-25 The creator of the rapid continuous pulping process. Alekseev, P. M. L. P. Zherebov, Sb. (Moscow Lesn. Prom.) pp. 62-80. (1965) Chem. Abs. 65 17191g

The L. P. Zherebov method for development of the industrial process for pulping is briefly discussed. A description of the technology of pulping straw and pinewood and the special equipment constructed for pulping are given. The production of straw is evaluated from technical and economical viewpoints.

B2-26 Use of agricultural residues in the cellulose and papermaking industry of Mexico. Amador, J. Assoc. Mex. Tech. Indus. Cellul. Pap. 8(3): 214-247. (1968) Chem. Abs. 72 R101955g

Discussed the use of various agricultural residues from sugarcane, cereals, and cotton as cellulose sources for the papermaking industry in Mexico. Predictions were made for the future of nonwood sources of cellulose.

B2-27 Beet pulp as a feed component. Kazakov, E. D., Goncharova, Z., Zhigalova, Y., Savina, I. (Mosk. Tekhnol. Inst. Pishchevoi Prom., Moscow, U.S.S.R.) Mukomol'No-Elevat. Kombikormovaya Prom-st. 3: 27-28. (1976) Chem. Abs. 55 092414

Composition of dried beetpulp indicates that it is a valuable feed material. Equilibrium moisture contents are given for crushed pulp, granulated pulp, and granulated pulp-containing molasses.

B2-28 Rice straw for fine papers. II. Bleaching of rice straw soda pulps of high reverted brightness. El-Taraboulsi, M. A., Abou Salem, A. H. (Alexandria Univ., Alexandria, U.A.R.) Tappi 50(11): 115A-118A. (1967)

A commercial rice-straw soda pulp and a mild experimental rice straw soda pulp were bleached by various procedures to determine what degree of brightness could be attained.

B2-29 Material of construction from organic waste material containing silica and pentosan. Fr. Demande 2226373 (C 04B, 04C), 9 pp. (1973) Chem. Abs. 83 029326

Furan resin obtained from rice husks (bran) or grain straw (wheat), and the ashes obtained by incineration of acid-treated organic waste material controlled to produce an appropriate amount of ash, are mixed after heat treatment to give an optionally expanded aggregate that has desirable properties for building.

B2-30 Characterization of straw pellets. 7. *In vivo* and *in vitro* fermentation of volatile fatty acids. Muenchow, H., Bergner, H., Zimmer, H. J. Arch. Tierernaehr. 25(1): 27-36. (1975) Chem. Abs. 83 095160

Experiments were carried out *in vivo* and *in vitro* to investigate the fermentation of volatile fatty acids influenced by different types of straw pellets, and by the source material, such as the straw from which the pellets were produced.

B2-31 On the treatability of straw board wastes in stabilization ponds with *Scenedesmus* sp. Environmental Health 9(3): 254-261. (1967)

Discussed aerobic treatment for strawboard wastes in oxidation ponds. Its effectiveness was judged by pH changes. A two-stage system (14-day bacterial fungal and 6-day optimum algal bacterial symbiosis) was used, with a 70% reduction in BOD. *Scenedesmus* was isolated to use during the second stage.

B2-32 Cellulose fiber slurries with refractory materials for moldings for use in casting metals. Hudson, E. D. (Pontefract Box Co., Ltd.) Brit. 1,129,642 (Cl.C08h), 09 Oct. 1968 Appl. 08 Jan. 1965. 4 pp.

Moldable compositions suitable for use in the production of high temperature heat insulators for riser sleeves in the casting of metals, or for hot tops used in steel ingot casting, were prepared by beating sugarcane trash or bagasse-, straw-, or softwood-waste to produce a pulp containing a very small proportion of free fibers.

B2-33 Alkaline extraction in bleaching straw pulp. Belchev, P., Angelov, Z., Khim. Ind. (Sofia) 37(8): 289-293. (1965) Chem. Abs. 64 9934h

To obtain bleached straw pulp with a high degree of whiteness, a three-stage bleaching was used in which the second stage was alkali extracted.

B2-34 Changes in the quantity of functional groups and the degree of polymerization during cooking and bleaching of straw pulp. Lengyel, P., Hernadi, S. Bumazhn. Prom. 8: 10-11. (1966) Chem. Abs. 65 15656b

Samples of two concentrated straw pulps, one manufactured by the kraft process and the other by a neutral sulfite process, were analyzed for their contents of CHO and CO_2H groups and their degree of polymerization, then bleached under various conditions and analyzed again.

C. Chemical Conversions

1. Chemical Treatments

C1-1 Prediction of the digestibility of forages by treatment of their cell walls with cellulolytic enzymes. Hartley, R. D., Jones, E. C., Fenlon, J. S. J. Sci. Food Agr. 25(8): 947-954. (1974)

A method for the prediction of the sheep *in vivo* dry matter digestibility and *in vivo* cell wall digestibility of grasses involves incubating grass cell walls with a commercial cellulase (*Oxyporus* sp.) for 16 hr and measuring the optical density of the filtrate at 324 nm.

C1-2 Improvements in the acetyl bromide technique to determine lignin and digestibility and its application to legumes. Morrison, I. M. J. Sci. Food Agr. 23(12): 1463-1469. (1972)

The acetyl bromide method for determining lignin content and digestibility of forage crops has been modified to allow the use of milligram samples and to decrease the operating time. Its applicability to legumes is demonstrated, and the differences between the results for grasses and legumes are discussed.

C1-3 Effect of alkali treatment of oat straw and two levels of soybean meal on ration utilization and fecal composition. Saxena, S. K., Otterby, D. E., Donker, J. S., Good, A. L. (Jawaharlal Nehru Krishi Vishwa Vidyalaya) Res. J. 6(2): 112-115. (1972) Biol. Abs. 56 005988

Two levels of soybean meal--isosoybean and isonitrogenous--were used in rations containing alkali-treated and untreated straws. A digestion trial was conducted using four male, castrated goats.

C1-4 Protein and urea supplements as affecting the digestibility, ruminal fermentation, and ruminal degradation of cellulose in straw fed animals. Bolduan, G., Voigt, J., Piatkowski, B. Arch. Tierernaehr. 22(6): 389-394. (1972)

Experiments were conducted on cows fed extracted soybean meal and urea as N sources in rations containing equivalent amounts of N and energy to test these N sources for their effect upon the level of digestibility and ruminal fermentation during straw feeding.

C1-5 Effect of lignin on the *in vitro* digestibility of wood pulp. Baker, A. J. J. Anim. Sci. 36(4): 768-771. (1973)

In vitro dry matter digestion and chemical analyses are shown for wood pulps with varying lignin contents made by the kraft or sulfate process from paper, birch, red oak, red pine, and Douglas-fir wood. Calculations from published *in vivo* data on 40 wood pulps made by 10 different pulping methods are given.

C1-6 Nutritive value of sunn-hemp hay and its supplementation to paddy straw as a complete feed for cattle. Reddy, M. R., Murty, V. N. Indian J. Anim. Sci. 42(8): 558-561. (1972)

Nutritive value of sunn-hemp (*Crotolaria juncea*) hay was determined using 12 adult Hariana cattle. The hay, prepared at the preflowering stage with minimum loss of nutrients, was supplemented to paddy straw at two levels--1:3 and 1:2 proportions.

C1-7 Acid detergent method for reduction of tannin interference in determining lignin of sericea lespedeza. Donnelly, E. D., Wear, J. I. Agron. J. 64(6): 838-839. (1972)

Apparent lignin was determined on stems and leaves of high- and low-tannin sericea lespedeza (*Lespedeza cuneata* (Dumont) G. Don) by two methods.

C1-8 Improving digestibility of straws for ruminant feed by aqueous ammonia. Waiss, A. C., Jr., Guggolz, J., Kohler, G. O., Walker, H. G., Jr., Garrett, W. N. J. Anim. Sci. 35(1): 109-112. (1972)

Digestibility and nutritive value of straws can be improved by treatment with aqueous ammonia at ordinary room temperature in a confined system. Experiments indicate that optimal process conditions are to treat rice straw by weight with 5% added ammonia and 30% added water for about 30 days at ambient temperatures.

C1-9 The treatment of rice straw with sodium hydroxide and its economic limitations in northern Thailand. Holm, J. Thailand J. Agr. Sci. 5(2): 89-100. (1972) Biol. Abs. 55 035136

One hundred kilos of rice straw were treated with NaOH by the Beckmann method. Digestibility trials were carried out on four wethers with untreated straw and on six wethers with treated rice straw.

C1-10 A semimicro method for the determination of lignin and its use in predicting the digestibility of forage crops. Morrison, I. M. J. Sci. Food Agr. 23(4): 455-463. (1972)

The lignin content of dried grasses can be measured, after prior removal of interfering phenolic materials, by dissolving the residue in 25% acetyl bromide in acetic acid and detrmining the absorption rate at 280 nm. The absorption values can also be used to predict the nutritive value for animals of dried grasses, hays, and silages.

C1-11 The digestibility and acceptability to sheep of chopped or milled barley straw soaked or sprayed with alkali. Garmona, J. F., Greenhalgh, J. F. D. J. Agr. Sci. 78(3): 477-485. (1972)

Milled straw was compared with straw soaked or sprayed with sodium hydroxide for its digestibility and acceptability to sheep. In a feeding trial of Latin-square design, involving six sheep, the following treatments of barley straws were compared: Coarsely milled, chopped and soaked in 1.5% NaOH, chopped and soaked in 3% NaOH, chopped and sprayed with 16% NaOH, and milled and sprayed with 16% NaOH.

C1-12 An assessment of the quality of forage from its cell wall content and amount of cell wall digested. Moir, K. W. J. Agr. Sci. 78(3): 355-362. (1972)

Grasses and legumes comprising poor- to good-quality temperate and tropical species were fed to either cattle or sheep in 36 digestibility experiments. Cell walls in these forages was the ash-free and protein-free residue after sequential extraction with acid-pepsin, organic solvents and either water for grasses or ammonium oxalate for legumes.

C1-13 Preparation and feeding value of ammoniated rye-straw pellets. Bergner, H., Marienburg, J. Arch. Tierernaehr. 21(6): 557-566. (1971) Biol. Abs. 54 017663

In digestion trials, chopped rye straw was cured in a multipurpose drier and pelleted with the addition of 10 kg of aqueous ammonia to 100 kg of chaffed straw and fed to sheep. Pellets of chaffed straw supplemented with 10% of dried sugarbeets before ammoniazation and pelleting, were fed to six dairy cows for 128 days.

C1-14 Digestibility of sodium hydroxide treated straw fed alone or in combination with alfalfa silage. Maeng, W. J., Mowat, D. N., Bilanski, W. K. Canad. J. Anim. Sci. 51(3): 743-747. (1971)

Rations of cell walls and energy of wet barley straw treated with sodium hydroxide at 100° C or mixed treated straw with alfalfa silage were fed at a constant level of dry matter intake to wethers in a double 4 x 4 Latin-square design.

C1-15 The utilization of alkali treated straw by sheep. Hoga, J. P., Weston, R. H. Austral. J. Agr. Res. 22(6): 951-962. (1971)

Sheep were fed a semipurified diet based on alkali-treated straw to determine the nutritive value of such forage, and to study various aspects of microbial synthesis in the rumen. Finely ground wheaten straw was treated with sodium hydroxide, which was subsequently neutralized with acetic and mineral acids; this forage was supplemented with minerals, branched chain fatty acids, and urea. The feed was offered to mature Merino wethers at 1,000, 700, and 400 g/day.

C1-16 The cellulose lignin complex in forages and its relationship to forage nutritive value. Allinson, D. W., Osbourn, D. F. J. Agr. Sci. 74(1): 23-26. (1970)

The relationship between the cellulose-lignin complex, voluntary consumption and dry-matter digestibility was examined while using forages of two varieties of Italian ryegrass and two legumes (lucerne and sainfoin). These forages had previously been shown to exhibit different intake-digestibility relationships. The cellulose, acid-detergent lignin and acid-detergent fiber contents of these forages, as well as their digestibility coefficients, were determined. Lignins were extracted from the fiber fractions and their ultraviolet difference spectra were determined.

C1-17 The potential digestibility of cellulose in forage and feces. Wilkins, R. J. J. Agr. Sci. 73(1): 57-64. (1969)

Techniques for measuring potential cellulose digestibility were examined, and the relationship between potential cellulose digestibility and *in vivo* cellulose digestibility was explored for a range of grasses (*Lolium perenne*, *Dactylis glomerata*, *Chloris gayana*).

C1-18 Semi-micro determination of cellulose in biological materials. Updegraff, D. M. Analyt. Biochem. 32(3): 420-424. (1969)

Describes a semimicro method for the determination of cellulose in microbial cultures, other biological materials, or pulp and paper products. Lignin, hemicellulose, and xylosans are extracted with an acetic acid/nitric acid reagent, and the remaining cellulose is dissolved in 67% H_2SO_4 and determined by the anthrone reagent.

C1-19 Alkaline and enzymatic treatments of rice hulls. Del Rosario, E., Ang, A. L. Phillipine Agr. 58(1-2): 24-29. (1974) Biol. Abs. 61 046755

Rice hulls (48 mesh, variety IR-20) were shaken with 1, 2, 5, and 10% NaOH at 29° C for 1 hr. After neutralization and filtration of the rice hull suspension, the residue was ovendried and analyzed for protein, crude fiber, and silica. Possible utilization of rice hulls as animal feed was discussed.

C1-20 Characterization of bound residues of nitrofen in rice and wheat straw. Honeycutt, R. C., Adler, I. L. J. Agr. Food Chem. 23(6): 1097-1101 (1975)

Crude lignin and cellulose isolated from rice and wheat straw after postemergence and preemergence treatment with (the herbicide) nitrofen^{14}C contained radioactivity. The lignin was purified to a constant specific radioactivity. About 30% of the radioactive residues in rice and wheat straw was in lignin. The cellulose from rice and wheat straw was hydrolyzed to glucose and derivatized to the osazone with phenylhydrazine. The osazone was recrystallized to constant specific radioactivity. Very little of the radioactivity in the rice and wheat straw was in cellulose.

C1-21 Composition and digestibility of cattle fecal waste. Lucas, D. M., Fontenot, J. P., Webb, K. E., Jr. J. Anim. Sci. 41(5): 1480-1486. (1975)

Three digestion trials were conducted with six yearling steers to study the apparent digestibility of fecal waste from steers fed a ground, high roughage finishing ration. In the first trial, the steers were fed a basal ration containing approximately 50% roughage. During second and third trials, a switchback design was used to study *in vivo* digestibility of the cattle fecal waste, which was substituted for 20% of the basal ration.

C1-22 Treating peanut hulls to improve digestibility for ruminants. Barton, F. E., II, Amos, H. E., Albrecht, W. J., Burdick, D. J. Anim. Sci. 38(4): 860-864. (1974)

Peanut hulls were treated chemically in attempts to improve their digestibility as a roughage for ruminants. Reagents used were ammonia, NaOH, Cl_2, calcium hypochlorite, dioxane/2, 2-dimethoxypropane, and dimethysulfoxide/1, 2-dimethoxyethone. Aerobic and anaerobic conditions were tested.

C1-23 The accuracy of predicting dry matter digestibility of grasses from lignin analysis by three different methods. McLeod, M. N., Minson, D. J. J. Sci. Food Agr. 25(8): 913917. (1974)

The lignin content of 50 samples of five grasses of known *in vivo* digestibility were determined by methods that utilize the solubility of lignin in potassium permanganate and in HCl-activated trigol, and in which the sample is refluxed with acid detergent after treatment with 72% sulfuric acid without any preliminary extraction.

C1-24 Predicting dry matter digestibility from acid detergent fiber levels in grasses as affected by a pretreatment with neutral detergent. McLeod, M. N., Minson, D. J.' J. Sci. Food Agr. 25(8): 913-917. (1974)

Acid-detergent fiber was determined in 50 grass samples of known *in vivo* dry matter digestibility, with and without a preliminary neutral detergent extraction.

C1-25 The feeding value of mixtures of alkali-treated straw and grass silage. Terry, R. A., Spooner, M. C., Osbourn, D. F. J. Agr. Sci. 84(2): 373-376. (1975)

Sheep digestibility and intake of a neutral mixture of alkali-treated straw and grass silages were compared with an all-silage diet, mixtures of treated straw, and silage adjusted to pH of 4 and 10, and with mixtures of untreated straw and silage. Calves were fed similar diets of grass silage, a neutral mixture of treated straw and silage; and offered treated straw and grass silage that were not premixed.

C1-26 Rates of *in vitro* forage fiber digestion as influenced by chemical treatment. Cross, H. H., Smith, L. W., Debarth, J. V. J. Anim. Sci. 39(4): 808-812. (1974)

The 72 hr *in vitro* digestibility and the rate of digestion of alfalfa or orchard grass cell walls were not changed by removing the solubles by neutral detergent extraction. Removing lignin increased cellulose digestibility. Immature forage fiber was digested 68% more rapidly than mature forage. Cellulose digestion was 30% faster in Na chlorite delignified cell walls than in total forage, neutral-detergent-fiber-extracted forage, or NaOH-extracted holocellulose.

C1-27 Effect of alkali treatment of wheat straw on feed consumption, digestibility and volatile fatty-acids production in cattle and buffalo calves. Chaturvedi, M. L., Singh, U. B., Ranjhan, S. K. Indian J. Anim. Sci. 43(8): 677-683. (1973)

The effect of wheat straw treated with NaOH upon 12 cattle (*Bos indicus*) and buffalo (*Bos bubalis*) calves was evaluated. A 3.3% NaOH solution was sprayed on 100 ml/kg chaffed wheat straw. In addition to the wheat straw, the animals were fed a concentrated mixture of one part groundnut cake, one part wheat bran, and one part barley; minerals; common salt; and vitamins recommended by the National Research Council.

C1-28 The nutritive value of some agricultural by-products. Economides, S., Hadjidemetriou, D. Cyprus Agr. Res. Inst. Tech. Bul. 18, pp. 1-12. (1974) Biol. Abs. 59 064362

The *in vivo* digestibility coefficients of vasectomized rams were measured. Energy values for each feedstuff were calculated from the digestible organic matter.

C1-29 Studies on the chemical degradation of cereal straw; Part 2. Treatment with sodium hydroxide as affecting the structure and digestibility of cereal straw. Piatkowski, B., Bolduan, G., Zwierz, P., Kauffold, P. Arch. Tierernaehr. 23(5): 435-445. (1973) Biol. Abs. 59 023479

During three experimental series, seven rations of wheat and barley straw treated with sodium hydroxide were fed to sheep to investigate the influence of sodium hydroxide treatment on the digestibility of nutrients in wheat and barley straw.

C1-30 Digestibility and feeding value of maize and some maize products for sheep and pigs. Boeve, J., Dijkstra, N. D., Smits, B. Versl. Landbouwkd Onderz. Agr. Res. Rpt. 803, pp. 1-47. (1973) Biol. Abs. 57 046840

Wether and pig digestibility of some products of the maize processing industry was determined. Digestibility of some products was also determined *in vitro*. Simple linear relations were derived between crude protein, true protein, crude fat, crude fiber, and their digested components; and between crude fiber content and the digestion coefficient of the N-free extract.

C1-31 Effect of delignification on the *in vitro* rumen digestion of poly saccharides of bagasse. Dekker, R. F., Richards, G. N. J. Sci. Food Agr. 24(4): 375-379. (1973)

Sugarcane bagasse was partially delignified by three chemical methods: Sodium sulfide/hydroxide (kraft process), sodium hydroxide, and sodium sulfite.

C1-32 On the relationship between chemical composition and digestibility *in vivo* of roughage. Muller, F. M., Dijkhuis, J. G., Heida, S. Versl. Landbouwkd Onderz. Agr. Res. Rpt. 789, pp. 1-12. (1973) Biol. Abs. 57 011781

In preparation of roughage samples for lignin determination, treatment of ether-extracted roughage with a solution of Pronase (a proteinase from *Streptomyces griseus*) at pH 7.4, instead of hot-water extraction, did not improve the correlation between lignin content and digestibility of organic matter in sheep.

C1-33 A cellulase digestion technique for predicting the dry matter digestibility of grasses. Jones, D. I., Hayward, M. V. J. Sci. Food Agr. 24(11): 1419-1426. (1973)

A digestion technique using a commercially-available crude cellulase preparation from *Trichoderma viride* is described.

C1-34 A semimicro method for the determination of lignin and its use in predicting the digestibility of forage crops. Morrison, I. M. (Hannah Dairy Res. Inst. Ayr, Scotland, U.K.)

After prior removal of interfering phenolic materials, the lignin content of dried grasses can be measured by dissolving the residue in 25% acetyl bromide in acetic acid and determining the absorption at 280 nm. The absorption values can also be used to predict the nutritive value of dired grasses, hays, and silages for animals.

C1-35 Studies on the nutritive value of cowpea. Gupta, P. C., Singh, R., Pradhan, K. Indian J. Anim. Sci. 46(3): 122-125. (1976)

To determine dry matter, crude protein, cell-wall constituents, and *in vitro* dry-matter digestibility, samples of 10 important cowpea (*Vigna sinensis*) strains or varieties were collected at preflowering, flowering, and postflowering stages.

C1-36 Chemical composition and digestibility of ryegrass straw. Han, Y. W., Lee, J. S., Anderson, A. W. (Dept. Microbiol., Oreg. State Univ., Corvallis, Oreg.) J. Agr. Food Chem. 23(5): 928-931. (1975)

The Lolium ryegrass straw was analyzed for cell-soluble matter, cellulose, and hemicellulose. Lignin, ash, and digestibility of each component was determined. Higher lignin levels resulted in reduced *in vitro* rumen digestibility. NaOH increased digestibility of whole straw, cell-soluble-matter-free straw, and rumen-digested straw.

C1-37 Sodium hydroxide treatment of barley straw: Effect of volume and concentration of solution on digestibility and intake by sheep. Jayasuriya, M. C. N., Owen, E. Anim. Prod. 21(3): 313-322. (1975)

Studies the effect of treatment of spring-sown barley straw with NaOH solution, and subsequent neutralization with HCl, upon digestibility and intake by sheep.

C1-38 Acid or alkali treated hardwood sawdust as a feed for cattle. Keith, E. A., Daniels, L. B. J. Anim. Sci. 42(4): 888-892. (1976)

Hardwood sawdust was treated with solutions of NaOH and H_2SO_4, ranging in concentration from 1.0-2,5%, for 24 hr. Holstein steers were fed rations containing 25% untreated, 1.0% NaOH, or 1.0% H_2SO_4 treated sawdust for 85 days.

C1-39 Hay preservation and quality improvement by anhydrous ammonia treatment. Knapp, W. R., Holt, D. A., Lechtenberg, V. L. Agron. J. 67(6): 766-769. (1975)

Determined the effectiveness of anhydrous ammonia (NH_3) as a preservative to prevent microbial activity and consequent dry matter and digestibility losses in hay that is intentionally or unintentionally stored at moisture levels of about 20%.

C1-40 A note on the *in vitro* utilization of sugarcane *Saccharum officinarum* tops compared with other fodders for cattle. Chaudhary, K. C., Sharma, K. C., Ahuja, S. P., Bhatia, I. S. Indian J. Anim. Sci. 42(9): 671-673. (1972) Biol. Abs. 59 046914

The chemical composition, cell-wall constituents and *in vitro* digestibility of dry matter and cellulose from sugarcane tops were compared with that from flowering plants of bajra, maize, and wheat straw.

C1-41 Physiochemical characterization of peanut hull as a potential fiber additive. Childs, E., Abajian, A. (Dept. Food Technol. Sci., Univ. Tennessee, Knoxville, Tenn.) J. Food Sci. 41(5): 1235-1236. (1976)

Dried, ground peanut hulls contained 34.56% lignin, 39.42% cellulose, 73.98% acid-detergent fiber, and 86.16% neutral-detergent fiber. The hulls bound 2 to 3 g H_2O/g sample, exchanged 1.55 milliequivalents cations/g sample, and bound 2.28 ± 0.87 micromoles Na taurocholate/100 nanograms sample.

C1-42 Utilization of rice hulls as ruminant feed. 2. Metabolism studies on the alkali-treated rice hull in sheep. Choung, C. C. (Cheju Natl. Univ., Cheju, So. Korea) Hanguk Ch'uksan Kakhoe Chi 18(2): 165-175. (1976)

Rice hulls treated with 2.5-15% by weight of NaOH, followed by neutralization with acid, drying, and pelleting 1:1 with alfalfa, were fed to sheep to study the metabolism of alkali-treated rice hulls in sheep.

C1-43 Process and apparatus to increase the feed value of lignocellulose-containing material. Lagerstrom, G. B., Mattson, O. A. Germ. Offen. 08 July 1974, 33 pp. Chem. Abs. 84 163194

The feed value of straw or other lignocellulose-containing material is improved by contact with an alkaline liquid, such as aqueous NaOH, especially with the addition of various nutrients. The excess alkaline liquid is drained from the grass before any alkalizing effect occurs, and when the liquid retained by the grass has reached a certain activity, the nutrient or acid solution is added to neutralize any alkali left in the straw.

C1-44 Oxidizing and hydrolyzing plant organic matter particles to increase the digestibility for ruminants. Jelks, J. W. U.S. 3939286 (426-312; A23K), 5 pp. (1973)

Digestibility of any cellulosic plant materials is increased by soaking, oxidizing, and hydrolyzing under pressure, with Mn or Fe and acid catalysts.

C1-45 Chemical composition and *in vitro* digestibility of coffee pulp. Rubio, U. J., Pineda, M. (Dept. Cien. Anim. Inst. Colombiana Agropecu., Bogota, Colombia) Rev. Inst. Colomb. Agropecu. 9(4): 489-496. (1974) Chem. Abs. 85 019391

Coffee pulp has high fiber and K contents. It has low nutritive value for monogastric animals and is limited for ruminants, since lignin-correlated dry matter true digestibility of coffee pulp is 65.50%--fresh, 68.80%--ensiled, and 71.50% inoculated; however, yeast inoculation or other methods, as yet undiscovered, may reduce lignin content and increase its usefulness.

C1-46 Effect of additives on the digestibility and assimilability of nutritive substances during beet pulp fattening of young cattle. Sidunova, A. K., Eliseev, I. G. (U.S.S.R.) Tr. Beloruss, S-Kh. Akad. 136: 110-118. (1975) Chem. Abs. 85 004173

A protein-mineral-vitamin supplement in granulated beet pulp rations used for fattening cattle led to faster weight gain (1,134-1,231 g/day; controls on mixed feed and feed concentrated 868-1,008 g/day); and increased rumen protein metabolism and digestibility coefficients for nutrients of the ration. The granulated feed was better utilized than ungranulated feed.

C1-47 On the nutritive value of dried potato and maize pulps for pigs. Roth, F. X., Kirchgessner, M. (Inst. Tierernaehr., Tech. Univ. Muenchen, Friesing Weihenstefhan, Germany) Wirtschaftseigene Futter 21(3): 225-332. (1975) Chem. Abs. 84 104254

The total digestible nutrients (TDN) content of the potato pulp was 580 g TDN/kg fodder. Dried maize pulp with 88% dry matter (DM) had a very high energy value at 865. The net energy for fattening for potato pulp was 1,860 kcal/kg DM; for maize pulp the net energy was 2,960 kcal/kg DM. Digestible crude protein formed only a moderate proportion at 170 g/kg for potato pulp and 140 g/kg for maize pulp. The methionine content was satisfactory at 3.5 and 2.5 g, respectively. Threonine levels of 4.2 for potato pulp and 3.7 g for maize pulp corresponded with that in soybean extract. The low lysine content in both pulps led to a relatively low biological value.

C1-48 Chemical composition and *in vitro* nutrient digestibility of some common straws and stovers. Gupta, P. C., Singh, R., Pradhan, K. (Dept. Anim. Nutr., Haryana Agr. Univ., Hissar, India) Haryana Agr. Univ. 3. Res. 4(3): 250-252. (1974) Chem. Abs. 84 104055

Reports the contents of protein, neutral detergent fiber, neutral detergent solubles, acid-detergent fiber, hemicellulose, lignin, cellulose, silica, *in vitro* dry-matter, and *in vitro* cell-wall digestibilities for nine straws and stovers of India--gram bhoosa, sugarcane tops, oat hulls, oat straw, jowar kerbi, wheat bhoosa, rice straw, sarson straw, and bajsa karbi.

C1-49 Optimization of a method for increasing the digestibility of cellulose residue from sugarcane. Cabello, A., Martin, P. C. (Cuba) Sobre Deriv. Cana Azucar 9(2): 34-47. (1975) Chem. Abs. 84 149515

Bagasse digestibility and degradability by rumen micro-organisms is improved by treatment with 6% NaOH at 6 atm for 15 min.

C1-50 Dioxane treatment to improve microbial digestibility of cellulosic fibers. Han, Y. W., Pence, J. W., Anderson, A. W. (Agr. Res. Serv., U.S. Dept. Agr., Corvallis, Oreg.) Appl. Microbiol. 29(5): 708-709. (1975)

The hemicellulose of grass seed straw can be extracted almost completely by acid detergent, but the treated residue is normally not digested by rumen micro-organisms. This residue can be made digestible if it is treated with acidic dioxane.

C1-51 Sodium hydroxide treatment of different roughages. Summers, C. B., Sherrod, L. B. (Texas Tech. Univ., Cent., Pantex, Tex.) Proc. Ann. Mtg. Amer. Soc. Anim. Sci., West. Sect. 26: 129-132. (1975)

Studies were conducted to determine the effect of NaOH treatment on the chemical composition and *in vitro* digestibility of peanut hulls, cottonseed hulls, corn cobs, corn stover, wheat straw, prefrost sorghum stubble, weathered sorghum stubble, alfalfa, forage sorghum hay, and Alicia bermudagrass. Each roughage was divided into two representative samples: One portion was treated with 5% NaOH at 50% moisture and then stored wet; the other was used as a dry control.

C1-52 Estimating digestible energy from chemical analyses. Fonnesbeck P. V., Harris, L. E., Kearl, L. C. (Utah State Univ., Logan, Utah) Proc., Ann. Mtg., Amer. Soc. Anim. Sci., West. Sect. 26: 121-1214. (1975)

Sheep, swine, rabbits and rats were fed diets formulated to contain 1-55% plant cell walls (from barley grain, soybean meal, wheat flour, soy flour, alfalfa hay, and barley straw), plus mineral and vitamin supplements. New chemical methods developed by the authors were used to analyze the diets.

C1-53 *In vitro* digestibility of barley straw treated with sodium hydroxide at elevated temperatures. Phoenix, S. L., Bilanski, W. K., Mowat, D. N. (Fabr. Res. Lab., Inc., Dedham, Mass.) Trans. ASEA 17(4): 780-782. (1974)

The *in vitro* digestibility (IVD) of barley straw was increased by treatment with NaOH, increase in moisture percentage, and increase in processing temperature. Increase in IVD and H_2O solubility occurred at 175° C for low treatment percentages of NaOH. IVD was greatest with the highest level of NaOH treatment.

C1-54 Studies on the utilization of rice straw. Part 4. The influence of cellulose lignin and silica on the dry matter disappearance in the rumen of fistulated cow. Toyakawa, K., Tsubamatsu, K., Nomura, T. J. Jap. Soc. Grassl. Sci. 21(1): 42-46. (1975) Biol. Abs. 61 023593

The disappearance of cellulose, lignin, and silica in rice straw packed in a silk bag and placed in a fistulated cow rumen was investigated quantitatively over a 5-day period.

C1-55 Sulfur supplements and *in vitro* digestion of forage cellulose by rumen micro-organisms. Spears, J. W., Ely, D. G., Bush, L. P., Buckner, R. C. (Univ. Kentucky, Lexington, Ky.) J. Anim. Sci. 43(2): 513-517. (1976)

Twenty-four hr *in vitro* incubations were used to determine the effects of adding various amounts of elemental S- or L-methionine on digestion of cellulose from either wood cellulose, Kentucky 31 tall fescue, Kenhy tall fescue, or Boone Orchardgrass.

C1-56 A comparison of indirect methods of predicting *in vivo* digestibility of grazed forage. Scales, G. H., Streeter, C. L., Denham, A. H., Ward, G. M. J. Anim. Sci. 38(1): 192-199. (1974)

In vivo digestibility coefficients were compared to those derived from various indirect methods of estimating digestibility. The best method was a modified two-stage Tilley and Terry, and a one-stage *in vitro* system was comparable. Standard grass hay diets gave more reliable results than did inoculum from grazing animals. Nylon bag, lignin ratio, $KMnO_4$ techniques were unreliable. Fecal N was reliable.

C1-57 Composition and *in vitro* digestibility of feces as affected by the alkali treated straw and three nitrogen sources in rations of lambs. Saxena, S. K., Good, A. L., Donker, J. D., Otterby, D. E. (Jawaharlal Nehru Krishi Vishwa Vidyalaya) Res. J. 8(3-4): 229-233. (1974) Biol. Abs. 61 023567

Using 60 lambs randomly divided into six groups, the effects of feeding two types of oat straws--soybean meal, urea and diammonium phosphate--were studied.

C1-58 The influence of physical treatments on composition and digestibility of roughage. Sandev, S. Z. Tierphysiol. Tierernaehr. Futtermittelkd 35(6): 310-315. (1975) Biol. Abs. 61 023581

Studied digestibility of four rations different in their physical form and rate of passage of roughage through the digestive tract in rams.

C1-59 The effect on digestibility of a new technique for alkali treatment of straw. Rexen, F., Vestergaard Thomsen, K. (Biotech. Inst., Kolding, Denmark) Anim. Feed. Sci. Technol. 1(1): 73-83. (1976) Chem. Abs. 85 092408

Treatment with up to 7% NaOH (measured as percent straw dry matter) linearly increased enzyme digestibility *in vitro*, and rate of digestion, but reduced cell wall constituency (neutral detergent fiber). Digestibility in sheep was increased by increments of NaOH $\leq$4-5%. Excess base was not washed from product, but unreacted NaOH did not appear great enough to cause concern.

C1-60 Nutritive value of soybean straw bhoosa. Pachauri, V. C., Negi, S. S. Indian J. Anim. Sci. 46(3): 118-121. (1976) Biol. Abs. 63 012319

The nutritive value of soybean bhoosa for yearling calves was compared with that of wheat bhoosa.

C1-61 The use of ammoniated rice hulls as roughage in barley beef production. Mitani, K., Tanimoto, H., Yoshimoto, T., Otani, I. (Faculty, Fisheries Anim. Husb., Hiroshima Univ., Fukuyama, Japan) J. Faculty Fisheries, Anim. Husb., Hiroshima Univ. 14(2): 275-285. (1975) 76 06 51004 FSTA

Holstein steers with an average initial live weight of 265 kg were used in a study on the effects of a diet of 80% finely ground barley and 18% ammoniated rice hulls for 34 weeks. Half were then transferred to a diet of 80% finely ground yellow corn and 18% rice. All steers were slaughtered approximately 46 weeks after the start of the feeding trial. Tables of results are given for various fattening performance and carcass quality characteristics, including hot carcass weight, dressing percent, marbling score, ribeye area, and carcass grade.

C1-62 Chemical quality and feeding value of Italian ryegrass silage. I. Effect of the growth stage of Italian ryegrass on fermentation quality and feeding value of silage. Masaoka, Y., Takano, N. (Natl. Grassl. Res. Inst. Nishinasuno, Japan) Sochi Shinkenjo Kenkyu Hokoku 8: 27-32. (1976) Chem. Abs. 85 141547

Italian ryegrass was harvested at various stages and ensiled. Samples were later tested for content, fermentive qualities, and digestion.

C1-63 The effect of fats and urea on *in vitro* cellulose digestion. Kesar, W. W., Church, D. C. (Oreg. State Univ., Corvallis, Oreg.) Proc., Ann. Mtg., Amer. Soc. Anim. Sci., West. Sect. 27: 342-344. (1976)

A closed *in vitro* system (24-hr digestion by rumen fluid) was used to study the effect of added corn oil (5 and 7%) and tallow (5 and 7%) to wood cellulose (Solka-Floc) with 1.234, 2.34, and 4.68% levels of urea expressed as percent of cellulose.

C1-64 Process for improving the digestibility of hemicellulose-free straw. Han, Y. W., Pence, J. W., Anderson, A. W. Patent-3 937 849, 3 pp.

Straw from which the hemicellulose has been removed is not digestible by ruminants. By application of an invention, this material is rendered digestible. The process of the invention involves treatment of the hemicellulose-free straw with dioxane containing a small proportion of hydrochloric acid.

C1-65 Predicted forage value of whole plant cereals. Fisher, L. J., Fowler, D. B. Canad. J. Plant. Sci. 55(4): 975-986. (1975) Biol. Abs. 61 035026

Determines dry matter yield, dry weight percent, *in vitro* digestible dry matter, *in vitro* indigestible organic matter, neutral detergent fiber, acid detergent fiber, ash and hemicellulose contents of spring- and fall-sown common wheat, barley, rye, and triticale and spring-sown durum wheat and oats for the period from late boot to maturity.

C1-66 The effect of nitrogen source on the *in vitro* cellulose digestion of chemically treated oat straw and poplar wood. Adeleye, I. O. A., Kitts, W. D. J. Agr. Sci. 82(3): 571-573. (1974)

Sources of N (biuret, uric-acid, urea) had no significant effect on untreated oat straw, or straw treated with NaOH or NH_4OH on cellulose digestion. Results for poplar wood were similar to oat straw.

C1-67 Chromatographic study of the carbohydrate contents of some annual plants. Bianciu, I., Constantinescu, O., Aptuda, N. Celluloza Hirtie 14(7-8-9-): 338-341. (1965) Chem. Abs. 63 15094c

A comparative study of the chemical composition of the sugars present in reed, wheat straw, and corncobs showed that from a papermaking point-of-view, the value of these raw materials decreases in the above order.

C1-68 The comparative nutritive value of grasses and legumes as livestock feed. Demarquilly, C., Jarrige, R. Vaxtodling 28: 33-41 Ref. (1974) Chem. Abs. 83 112426p

A review with 53 references on the chemical composition and digestibility of grasses and legumes, and the advantages and disadvantages of each as a ruminant feed.

C1-69 Determining hemicellulose in plant cell walls. Fonnesbeck, P. V., Harris, L. E. J. Anim. Sci. 33(1): 283. (1971)

The hydrolysis of hemicellulose and cellulose from cell-wall samples of barley straw, wheat bran, and Kentucky bluegrass was studied by refluxing with various concentrations of H_2SO_4 for various times.

C1-70 Histochemical studies on the rumen digestion of rice straw cell wall and on the chemical determination of its non-nutritive residue. Kawamura, O., Senshu, T., Horiguchi, M., Matusumoto, T. Tohoku J. Agr. Res. 24(4): 183-191. (1973) Chem. Abs. 81 103672y

Relations between the distribution of cell-wall constituents of rice straw internode and the rumen digestion of the cell wall were histochemically studied with the nylon bag technique, and the nonnutritive part of of the cell wall was characterized.

C1-71 Chemistry of hemicellulose. Tsujisaka, Y., Takenishi, S. (Osaka Shiritsu Kogyokenkyushu, Osaka, Japan) Kagaku To Koguo (Osaka) 41(9): 422-431. (1967) Chem. Abs. 68 41122p

A review with 64 references. Structures of xylan, arabinoxylan araban, mannan, galactomannan, glucomannan, galactan, and arabinogalactan and their distribution in wood, straw, and seed are discussed.

C1-72 Technological properties of wheat straw as a raw material for the hydrolysis and yeast-producing industry. Korol'kov, I. I., Vysotskaya, I. F., Papashnikov, L. M., Kalyuzhnyi, M. Ya, Ivanyukovich, V. A. Sb. Tr., Gos, Nauch.-Issled. Int. Gidroliz. Sul'fitno-Spirt. Prom. 15: 43-52. (1966) Chem. Abs. 67 91854d

On the basis of chemical analysis and experimental cooks, wheat straw is believed to be useful for the hydrolysis industry. In a pilot plant hydrolyzer, of 2.8 m^3 capacity, a yield of sugars of 41%, based on oven-dry raw material, was obtained under the following conditions: 30 min preheating to a temperature corresponding to a pressure of 3 atmospheres; percolation time of 150 min; and consumption of H_2SO_4 (as the monohydrate) 14%, based on oven-dry raw material and a rate of hydrolyzate withdrawal of 1.6 m^3/hr.

C1-73 Amino acid composition of roughage. II. Table of amino acid contents in grasses. Nakashima, Y., Kikuchi, S. (Iwate Univ., Morioka, Japan) Iwate Daigaku Nogakubu Hokoku 10(2): 95-108. (1970) Chem. Abs. 75 85157c

Amino acid contents in 15 grasses, 8 legumes, and 3 straws were measured in relation to the stage of growth.

C1-74 Estimation of crude cellulose in feeds. Nehring, K. Arch. Tierernaehr. 19(6): 453-473. (1969) Biol. Abs. 51 096947

Systematic studies were conducted to investigate factors that influence the results of crude cellulose determinations in feeding-stuffs estimated by the method of Kueroschner-Hanak.

C1-75 Contribution to the use of hydrolyzed yeasts in compound forages for broiler chickens. Petkova, G., Balyozov, D. Zhivotnov'd Nauki 12(8): 72-77. (1975) Chem. Abs. 84 163258p

There were no negative effects on weight gains and feed utilization of broiler chickens after balancing the conconcentrated composition by by substituting yeast and DL-methionine fully, or partially, for fishmeal proteins and essential amino acids, and addition of fats for increasing the energy value of the concentrate.

C1-76 Bluegrass straw compsition and utilization. Early, R. J., Anderson, D. C. (Washington State Univ., Pullman, Wash.) Proc. Ann. Mtg., Amer. Soc. Anim. Sci., West. Sect. 27: 185-188. (1976)

Straw samples of five Kentucky bluegrasses--Merion, Nugget, Adelphi Fyl King, and Garfield--were tested for composition and utilization.

C1-77 Effects of feeding alkali-treated oat straw supplemented with soybean meal or nonprotein nitrogen on growth of lambs and on certain blood and rumen liquor parameters. Saxena, S. K., Otterby, D. E., Donker, J. D., Good, A. L. J. Anim. Sci. 33(2): 485-490. (1971)

Studies were made on lambs fed diets containing alkali-treated oat straw, soybean meal, urea, $(NH_4)_2HPO_4$, or untreated straw as N sources.

C1-78 Effect of chlorocholine chloride on the structure of wheat straw. Scherbakov, V. A. (Inst. Eksp. Bot., Minsk, U.S.S.R.) Dok. Akad. Nauk. Beloruss. 12(6): 546-549 SSR. (1968)

Under the influence of chlorocholine chloride (CCC), the wall thickness of the lowest internodes of wheat straw, the number of vascular bundles, and sometimes the thickness of the schlerenchyma ring are enlarged. The CCC effect is greater on varieties susceptible to lodging and does not depend upon the kind of soil.

C1-79 Photochemical degradation of cellulose. Simimescu, Dr., Roxmarin, Gh., Bulacovschi, V. Celluloza Hirtie 14(7-8-9): 319-335. (1965)

The ultraviolet irradiation attacks the β-glucosidic bonds of cellulose.

C1-80 Detection and determination of chlorocholine chloride in biological material. Bayzer, H. (Osterreichische Stickstoffwerke A.-G., Linz/Donau, Austria) Monatsh. Chem. 98(5): 1826-1831. (1967) Chem. Abs. 67 116128k

Describes a method for isolation and quantitative determination of micro amounts of chlorocholine chloride, extracted with EtOH from green leaves, fruits, grains, straw, and flour.

C1-81 Pretreatments to enhance chemical, enzymatic, and microbiological attack of cellulosic materials. Millett, M. A., Baker, A. J., Satter, L. D. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 193-219. (1975)

Reviews the current status of effors to modify the reactivity of cellulose and lignocellulose by physical and chemical manipulations, with special emphasis on their applications to wood residue.

C1-82 Discussion of pretreatments to enhance enzymatic and microbiological attack of cellulosic materials. Nystrom, J. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 221-222. (1975)

The Natick laboratory has found pretreatment (preferably physical) to have reasonable kinetics during enzymatic hydrolysis. We need continued efforts to find a more reasonable substrate pretreatment because pretreatment is the greatest cost factor in enzymatic processing of waste cellulose.

C1-83 A rapid test for celluloytic activity. Stranks, D. W., Bieniada, J. Int. Biodeterior Bul. 7(3): 109-111. (1971)

One to 10 microliter of enzyme solution is applied to a monolayer of cellulose in agar and incubated at 50° C. The formation of a clear zone indicates cellulase activity. This test can be applied to cellulases and hemicellulases.

C1-84 Upgrading cereal straws. Walker, H. G., Kohler, H. O., Graham, R. P., Hart, M. R., Garrett, W. N. (Western Regional Res. Lab., Agr. Res. Serv., Berkeley, Calif.) U.S. Dept. Agr., Res. Serv. ARS-NC-40, pp. 105-121. (1967)

Chemical treatment to upgrade straw for use as animal feed was studied.

C1-85 Sodium hydroxide treatment of straw economic problems and possible solutions. Greenhalgh, J. F. D., Fernandez, C J., Mehmed, E. A. J. Sci. Food Agr. 24(4): 494-495. (1973)

Economic limitations of the NaOH process to treat straw are given.

C1-86 Sodium hydroxide treatment of straw and other fibrous feeding-stuffs to improve their digestibility and intake by sheep. Owen, E., Jayasuriya, M. C. M., Mwakatundu, A. G. K. J. Sci. Food Agr. 24(4): 493-494. (1973)

Describes efforts to improve methods of NaOH treatment of straw.

C1-87 Processing cellulosic wastes for feed. Walker, H. G., Jr., Kuzmicky, D. D. Agr. Res. 74(60): 150-156. (1972)

Alkali processing procedures and costs are discussed.

C1-88 Rice straw, barley straw and alfalfa hay cube digestibility and total digestible nutrient in yearling heifers. Algeo, J. W., Hibbits, A. G., Wooden, G. R., Bris, E. J. J. Anim. Sci. 33(1): 274. (1971)

Rice straw, barley straw, and alfalfa hay were compared for digestibility in heifers.

C1-89 Laboratory methods of evaluating feeding value of herbage. Barnes, R. F. Butler, G. W., Bailey, R. W. (eds.) Chem. and Biochem. of Herbage, Vol. 3 Academic Press, New York, pp. 179-214. (1973)

Reviews laboratory methods for evaluating feeding values of herbage and describes chemical, physical, *in vivo*, and *in vitro* methods.

C1-90 Dry matter digestibility of olive pits as compared with various other feedstuffs. Bris, E. J., Morris, M. K., Algeo, J. W., Hibbits, A. G., Wooden, G. R. J. Anim. Sci. 33(1): 276-277. (1971)

Intraruminal nylon bag trials were used to determine the digestibility of olive pits in cattle.

C1-91 Determining holocellulose and lignin in feeds. Fonnesbeck, P. V., Harris, L. E. J. Anim. Sci. 31(1): 240. (1970)

A low protein cell wall residue is prepared by extracting the cell contents with pepsin and a detergent solution at pH 3.5. The loss of weight upon treatment of the dry cell wall residue with 72% sulfuric acid is reported as holocellulose. The loss of weight upon ignition is reported as lignin.

C1-92 Treatment of farm wastes for livestock feed. Guggolz, J., McDonald, G. M., Walker, H. G., Jr., Garrett, W. N., Kohler, G. O. J. Anim. Sci. 33(1): 284. (1971)

A variety of agricultural residues were treated with NaOH under steam pressure, which improved digestibility. The product proved acceptable to lambs.

C1-93 Alkali treated straw rations for fattening lambs. Javed, A. H., Donefer, E. J. Anim. Sci 31(1): 245. (1970)

The increased nutritive value of the NaOH treated straw, supplemented with molasses, yielded growth results approaching the control alfalfa ration.

C1-94 Ammoniated roughages in steer finishing rations. Klett, R. H., Maben, B. G., Sherrod, L. B. J. Anim. Sci. 35(1): 231. (1972)

Performance and carcass traits were not significantly affected by roughage source. Ammoniation did not improve feedlot or carcass traits of cattle.

C1-95 Digestibility of sodium hydroxide straw with alfalfa silage. Maeng, W. J., Mowat, D. N. J. Anim. Sci. 33(5): 1168. (1971)

Straw treated with NaOH was more digestible by sheep than untreated straw. Both kinds of straw were fed in combination with alfalfa silage.

C1-96 Sodium hydroxide stover or straw silage in growing rations. Mowat, D. N., J. Anim. Sci. 33(5): 1155. (1971)

Six percent NaOH treated barley straw or corncobs were ensiled, and fed to calves. Growth was normal until treated material reached 50% of the ration.

C1-97 Composition and digestibility of sugarcane varieties. Pate, F. M., Coleman, S. W., James, N. I. J. Anim. Sci. 41(1): 338. (1975)

Chemical composition and *in vitro* digestibility experiments were conducted for 66 sugarcane varieties.

C1-98 Sodium hydroxide treated wheat straw rations for sheep. Shin, H. T., Garrigus, U. S., Owens, F. N. J. Anim. Sci. 41(1): 417. (1975)

Digestion trials were conducted to determine the value of NaOH treated straw for sheep.

C1-99 Studies on ammoniated straw pellets used as sole basal diet in the feeding of ruminants. 2. Studies on processes of ruminal fermentation in relation to milk composition and the milk yields of cows. Bergner, H., Muenchow, H., Wilke, A., Schoenmuth, G. (Sekt. Tierprod. Veterinaermed., Humboldt Univ., Berlin) Arch. Tierernaehr. 26(6): 417-426. (1976) Chem. Abs. 85 092563

Chemically treated wheat straw pellets resulted in milk production equal to that obtained by conventional feeding practices. Untreated straw reduced feed consumption, milk yields, and percentage of milkfat.

C1-100 Soluble silica in rumen cultures. Smith, G. S., Smith, E. C., De La Torre, R., Neumann, A. L. J. Anim. Sci. 33(1): 246. (1971)

Natural forages and purified cellulose were used with substrates to study effects of soluble silica on degradation of fiber.

C1-101 Sodium hydroxide treatment of different roughages. Summers, C. B., Sherrod, L. B. J. Anim. Sci. 41(1): 420. (1975)

The response to NaOH treatment of various roughages, such as peanut hulls, cottonseed hulls, and corncobs depended on the species of roughage treated.

C1-102 Hydroxides for treating crop residues. Waller, J. C., Klopfenstein, T. J. Anim. Sci. 41(1): 424. (1975)
Growth trials on lambs were conducted to evaluate corncobs treated with NaOH, $Ca(OH)_2$ and/or NH_4OH.

C1-103 Laboratory evaluations of chemically treated straw. Yu, Y., Thomas, J. W., Emery, R. S. J. Anim. Sci. 31(5): 1013. (1970)
Chlorine compounds (organic chloride, $NaClO_2$, NaClO bleach, $Ca(ClO)_2$, $KClO_3$) and Cl_2 gas were examined for their effectiveness in improving the nutritive value of straw in laboratory silos.

C1-104 Treatment of straw with chlorine compounds and radiation. Yu, Y., Thomas, J. W., Emery, R. S. J. Anim. Sci. 33(5): 1155. (1971)
Wheat straw digestibility was improved by treatment with chlorine compounds and radiation.

C1-105 Studies on forage cell walls. 2. Conditions for alkali treatment of rice straw and rice hulls. McManus, W. R., Choung, C. C. J. Agr. Sci. 86(3): 453-470. (1976)
A number of studies on NaOH treatment of rice hulls and straw are reported.

C1-106 Fiber composition and forage digestibility by small ruminants. Short, H. L., Blair, R. M., Segelquist, C. A. J. Wildlife Mangt. 38(2): 197-209. (1974)
Major distinguishing characteristics of different types of forage were related to digestibility as estimated by the nylon bag technique.

C1-107 Wheat straw and urea in pelleted rations for growing-fattening sheep. Bhattacharya, A. N., Khan, A. R. J. Anim. Sci. 37(1): 136-140. (1973)
Urea and soybean meal were N sources in a 45% straw diet. No significant differences in weight gain or food intake were observed.

C1-108 Chemical and biological treatment of feeds. Ed. 2. Chugunkov, Y. G. (U.S.S.R.) Khimichna Ta Biologichna Obrobka Kormiv, 64 pp. (1975) Chem. Abs. 83 16239s
Title only translated.

C1-109 Improvement of the nutritional value of animal feed by micro-organisms. Kitahara, K., Oi, A., Mori, S. Nippon Nogyo Kenkyusho Nempo, pp. 48-79. (1967) Chem. Abs. 70 2570e
A strain of *Clostridium cellobioparum* was isolated from the rumen of cows and used for preparing silage from rice straw.

C1-110 Paper composition and estimated nutritive value. Mertens, D. R., Van Soest, P. J. J. Anim. Sci. 33(1): 293. (1971)
Various kinds of papers, such as brown paper or glossy paper, were analyzed by the detergent fiber system for lignin and other fiber constituents, and for metals. There was much variation. The digestibility depended on the lignin content. Cu content was up to 34 ppm, which could be toxic to rumen microbes.

C1-111 Alkali treated straw and nonprotein nitrogen sources for lambs. Saxena, S. K., Otterby, D. E., Donker, J. D., Good, A. L. J. Anim. Sci. 31(1): 252. (1970)

Lambs were fed untreated and alkali-treated straw, supplemented with various N sources. Lambs that ate treated straw had better feed conversion efficiency.

C1-112 Urea and molasses in high rice straw rations. White, T. W., Reynolds, W. L., Hembry, F. G., Habetz, R. J. Anim. Sci. 36(1): 220-221. (1973)

Rice straw was 79-96% of ration. Nitrogen plus readily available carbohydrate was 20% of ration. One-percent urea improved digestibility.

C1-113 A note on the effect of lime and calcium carbonate supplementation on the nutritive value of paddy straw. Nath, K., Sahai, K., Keher, N. D. J. Agr. Sci. 70(2): 169-170. (1968)

Paddy straw was supplemented with $CaCO_3$ or lime, on nine bullocks. Digestion coefficient of dry matter, crude protein, ether extract, and total carbohydrate or balances of N and P were not significantly improved. Supplements helped overcome negative Ca balances of animals on straw rations. Small amounts (4 oz.) of wheat bran helped meet the P requirements of adult bullocks.

C1-114 Effect of starch on the utilization by sheep of a straw diet supplemented with urea and minerals. Mulholland, J. G., Coombe, J. B., McManus, W. R. Austral. J. Agr. Res. 27(1): 139-153. (1976) Biol. Abs. 62 005983

Individually penned Border Leicester crossed with Merino wethers, aged 11 months, were fed *ad libitum* for 16 weeks on a basal ration of ground, pelleted oat straw, urea, and minerals, supplemented with 0, 5, 10, 15, 20, 30, or 40% starch. The diets contained equal percentages of N and minerals.

C1-115 Bound residues of nitrofen in cereal grain and straw. Honeycutt, R. C., Wargo, J. P., Adler, I. L. (Res. Lab. Rohm and Haas Co., Spring House, Pa.) ACS Symposium Ser. 29, pp. 170-172. (1976)

Treatment of rice and wheat with ^{14}C labeled nitrofen showed considerable incorporation of ^{14}C into plant tissue. Straw had 25-50% of ^{14}C residue into lignin; grain had 64-70% of ^{14}C in starch.

C1-116 Digestibility of grain sorghum stover and wheat straw supplemented with NPN (nonprotein nitrogen). Swingle, R. S., Waymack, L. B. (Dept. Anim. Sci., Univ. Arizona, Tucson, Ariz.) Proc., Ann. Mtg., Amer. Soc. Anim. Sci., West. Sect. 26: 125-128. (1975)

In digestion studies, the use of a NPN supplement with low-quality roughages appears to have several advantages over conventional difference methods. A digestion trial was conducted with growing steers to determine digestibility and total digestible nutrients of sorghum stover--51%, and wheat straw--45%.

C1-117 Improving the nutritive values of rice straw and rice hulls by ammonia treatment. Itoh, H., Terashima, Y., Tohrai, N., Matsui, Y. (Kitasato Univ., Towada, Japan) Nippon Chikusan Gakkai-Ho 46(2): 87-93. (1975) Chem. Abs. 82 154254

Rice straw and rice hulls were treated with 10% NH_3 by weight and 30% water by weight for 12 months. Crude protein content was tripled. *In vitro* rumen digestibility increased by 10%. Authors feel ammonia treatment of straws and hulls to enhance their feed value for ruminants is worthy of active consideration.

C1-118 Utilization of urea with sugar beet by-products by dairy cows. Senel, H. S., Dilmen, S. Ankara Univ. Vet. Fak. Derg. 18(2): 161-182. (1971) Biol. Abs. 56 023469

Studied possible effects of high level (up to 5.5%) urea and dried beetpulp with molasses in concentrate rations on feed intake, lactation-milk efficiency, ruminal pH, rumen fluid and blood-volatile fatty-acid concentration. No toxic signs were observed.

C1-119 Processing cereal straws for feed use. Kohler, G. O., Walker, H. G., Jr., Graham, R. P., Hart, M. R., Garrett, W. N. Cereal Sci. Today 19(9): 384. (1974)

Treatment with alkali or aqueous ammonia followed by compaction is the most promising processing treatment today for converting lignin-cellulose-hemicellulose into a form rumen micro-organisms can use.

C1-120 The uniformity and nutritive availability of cellulose. Van Soest, P. J. Fed. Proc. 32(7): 1804-1808. (1973)

Describes the variability of natural and prepared celluloses and their varying susceptibility to fermentation.

C1-121 Forage potential of soybean straw (for sheep). Gupta, B. S., Johnson, D. E., Hinds, F. C., Minor, H. C. Agron. J. 65(4): 538-541. (1973)

Nutritive value of soybean plants and plant parts at various stages of maturity were determined by chemical methods, *in vitro* methods, and feeding to ewes.

C1-122 Separation of protein from fiber in forage crops. Kohler, G. O., Chrisman, J., Bickoff, E. M. Proc. of a Symposium: Alternative Sources of Protein for Anim. Prod., Blacksburg, Va. Natl. Acad. Sci., Wash., D.C., pp. 42-60. (1973)

Describes the process of fractionation of alfalfa and the manufacture of Pro-Xan (leaf protein concentrate from alfalfa).

C1-123 Ammoniated roughages in feedlot rations. Lippke, H., Riewe, M. E. Tex. Agr. Expt. Sta. Prog. Rpt. 2963-2999, pp. 17-19. (1971)

Cattle on feedlot rations containing either 10% ammoniated rice hulls, ammoniated sorghum stubble, or ammoniated wheat straw appeared to perform equally well.

C1-124 Effect of supplementation of urea and molasses on utilization of wheat straw by dairy heifers. Sharma, V. V., Taparia, A. L., Jhanwar, B. M. Indian J. Dairy Sci. 25(3): 153-158. (1972)

An experiment with four dairy heifers was conducted for 96 days to evaluate feeding urea at 13g urea/kg straw and 1 kg molasses per day. Urea improved utilization while molasses depressed it.

C1-125 Evaluation of ammonium lignin sulfonate as a nonprotein nitrogen source for sheep. Croyle, R. C., Long, T. A., Hershberger, T. V. J. Anim. Sci. 40(6): 1144-1149. (1975)

In vitro and *in vivo* trials indicated that ammonium lignin sulfonate N was generally similar to urea N as a nonprotein N source for sheep.

C1-126 *In vitro* evaluation of ammonium base sulfite liquor as an energy and nitrogen source for ruminants. Kromann, R. P., Wilson, T. R., Cantwell, G. S. J. Anim. Sci. 42(4): 993-1001. (1976)

N from low levels of ammonium sulfite liquor (ASL) was not as well utilized by sheep (*in vitro*) as that from urea-containing diets. High levels (20-100%) of ASL had an inhibitory effect on gas production and protein synthesis. At low levels, softwood ASL appeared to be more beneficial to microbial metabolism than softwood-hardwood blends of ASL.

C1-127 Cellulose fermentation: Effect of substrate pretreatment on microbial growth. Han, Y. W., Callihan, C. D. Appl. Microbiol. 27(1): 159-165. (1974)

Studied the effect of chemical, physical, and enzymatic treatments of rice straw and sugarcane bagasse on the microbial digestibility of cellulose. Treatment with 4% NaOH for 15 min at 100° C increased the digestibility of cellulose from 29.4 to 73%. Treatment with the 5.2% NH_3 could increase digestibility to 57.0%. Treatment with sulfuric acid and crude cellulase preparation solubilized cellulose but did not increase the digestibility. Grinding or high-temperature cooking of the substrate had little effect on increasing the digestibility.

2. Production of Chemicals

C2-1 Cellulose saccharification as an alternate source of glucose for commercial and food use. Elder, A. L. Gaden, E. L., Jr. (ed.) Sixth Biotechnol. Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 275-284. (1976)

The world shortage of food energy can be alleviated by an increase in production of cane and beet sugar, starch and monosaccharides from cereals and tubers, possible synthesis of sucrose, animal feed from yeasts, and molds and bacteria, with a source of fermentables coming from cellulose by use of cellulases.

C2-2 Cellulose saccharification for fermentation industry applications. Seely, D. B. Gaden, E. L., Jr. (ed.) Sixth Biotechnol. Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 285-292. (1976)

Gives a brief overview of current practices in the fermentation of industry, with an examination of how cellulosic-derived sugar will fit with present trends.

C2-3 Sugar from paper filters. Przyklenk, M., Fengel, D. Naturwissensenschaften 62(12): 575. (1975) Chem. Abs. 54 61567w

The filtration of 300 to 500 ml H_2O through filter paper washed out approximately 0.1 to 0.2 mg arabinose in addition to trace amounts of glucose, galactose, and oligosaccharide in an experiment to test the amounts and kinds of sugars in filter paper.

C2-4 Hydrolysis of hemicelluloses from a mixture of cornstalks and straw by dilute sulfuric acid solutions. Dudkin, M. S., Starichkova, V. E. (Odess. Tekhnol. Inst., Lomonosova, Odessa, U.S.S.R.) Zh. Prikl. Khim. (Leningrad) 41(12): 2711-2717. (1968) Chem. Abs. 70 88963

Cornstalks and straw were finely cut and hydrolyzed separately, or together, as a mixture of 0.2N H_2SO_4 at 101° C. Hydrolysis took 40 to 152 min. Yields were determined of the easily hydrolyzed polysaccharides containing D-xylose, L-arabinose, D-glucose, D-galactose, and uronic acids, and of difficult-to-hydrolyze polysaccharides containing D-xylose, L-arabinose, and D-glucose.

C2-5 Lignins from straw and lignite. Investigation of very new and old lignin. Redinger, L., Rieche, A., Lindenhayn, K. (Deut. Akad. Wiss., Berlin) Monatsber. Deut. Akad. Wiss. Berlin 8(3): 197-202. (1966) Chem. Abs. 67 3870c

Rye straw and lignite were subjected to alkaline degradation with 20 and 16% NaOH, respectively, at 220° C for 3-6 hr and the lignins obtained were compared with milled wood lignins obtained by milling and extraction with damp dioxane.

C2-6 Native plant residues (hop stems, straw, rape nusks, etc.) as raw material for furfural production. Krack, H., Krutul, D. Postepy Nauk. Polniczych. 12(6): 81-86. (1965) Chem. Abs. 65 17194a

Plant residues, in order to serve as good raw material for furfural production, must contain not less than 15-20% pentosans to give at least 55-60% of the theoretical furfural yield. The raw material must be available in great quantity on not too large an area. Several byproducts could be utilized. The following plants were investigated: Flax straw, hop stems, rape straw, reeds, and tobacco stems.

C2-7 Plastics from wood. Deanin, R. D. Appl. Polymer Symposium 28: 71-76. (1975)

Discusses existing polymers from wood and cellulose and proposals for future research.

C2-8 Waste conversion process. Ferguson, S. R. U.S. 3,875,317 (Cl 426-373; A23k) 1 Apr. 1975 181 319 17 Sept. 1971. 5 pp.

Converts stable waste of manure and straw and grandstand waste (mostly paper) into useful products. Cellulose of straw and paper is converted into molasses for feed. After separation from the other ingredients, the manure is converted to fertilizer, and the lignin is converted to charcoal, acetone, acetic acid, and other volatile byproducts.

C2-9 Xylose. Jaffe, G. M., Szkrbalo, W., Weinert, H. (Hoffman La Roche, Inc.) U.S. 3,784,408, Cl 127/37; C13K) 08 Jan. 1974, Appl. 863, 558, 29 Oct. 1969. 5 pp.

Xylose was manufactured from hydrolyzates of cellulosic materials and hydrogenated in the presence of a catalyst, Raney Ni, to give xylitol.

C2-10 Aqueous crystallization of xylitol. Jaffe, G. M., Weinert, H. (Hoffman-La Roche, Inc.) U.S. Pub. Pat. Appl. B 519446. (Cl 260-637R; C07C) 24 Feb. 1976 Appl. 296,404 10 Oct. 1972. 4 pp.

Crystalline xylitol containing less than 0.10 weight percent xylose was obtained from a mixture of xylose and xylitol by providing an aqueous solution of 50-75% weight percent xylitol less than 4 weight percent xylose and 20 to 45 weight percent H_2O and practically crystallizing xylitols from the aqueous solution. The impure xylitol was prepared by Raney Ni hydrogenation of xylose from ground oat hulls.

C2-11 Preparation of sugars from plant wastes. Repka, V. P., Panasyuk, L. V. (Dnepropetrovsk. Khim.-Teknol. Inst., Dnepropetrovsk, U.S.S.R.) Khim. Tekhnol. 13: 55-58. (1968) Chem. Abs. 71 72191b

The plant wastes were mixed with 1.5 parts of 4, 6, or preferably 8% HCl, boiled under reflux for 15-20 min, and filtered. Reducing substances were determined in the filtrate. Treatment was tried on corn plant stumps, sunflower brans, wheat straw, cornflower membranes, buckwheat brans, millet brans, and remnants from preparation of tanning extracts.

C2-12 Specific features of the crystallization of xylitol from corn cob hydrolyzates. Reznikovskii, A. U., Soboleva, G. D. (U.S.S.R.) Microbiol. Sin, Sb Ts 1972 4: 12-17 (Russ) From Ref. Zh. Khim. 1973, Abs. No. 15P30. Chem. Abs. 81 39355k

The qualitative composition of corncob hydrolyzates differed from cotton husk hydrolyzates, and crystalline xylitol having better properties, was obtained from 88% solutions than from 92% solutions. Sorbitol had no effect on crystallinity but decreased quality of xylitol. In corncob hydrolyzates, erythritol, glycol, ethanol formed as impurities.

C2-13 Rice straw as a possible raw material for hydrolysis. Savinykh, A. G., Glazman, B. A., Nikolaeva, N. S. (U.S.S.R.). Chem. Abs. 85 189237

(Title only translated; no abstract given.)

C2-14 Kinetic model for the preparation of glycerol by the catalytic hydrogenolysis of glucose. Stefoglo, E. F., Ermakova, A., Vasyunina, N. A., Klabunovskii, E. I. (U.S.S.R.) Khim. Pram. (Moscow) 49(8): 576-580. (1973) Chem. Abs. 80 61336n

The catalytic conversion of glucose to glycerol, propylene glycol, erytritol, xylitol, ethylene glycol and unidentified compound mistures can be carried out directly by adding glucose to the aqueous suspension of nickel on Kieselguhr heated to 175° to 230° C. and applying H pressure in two steps--hydrogenate glucose to sorbitol, then add sorbitol to the heated catalyst suspension.

C2-15 Sugar production from agricultural woody wastes by saccharification with *Trichoderma-viride* cellulase. Toyama, N., Ogawa, K. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a Chemical and Energy Resource. John Wiley and Sons, New York, pp. 225-244. (1975)

The saccharification of agricultural woody wastes, such as rice straw, bagasse, and sawdust, was studied while using a commercial enzyme preparation, Cellulase onuzuka derived from *Trichoderma viride*, or the solid culture extracts of the fungus. Delignifying methods of these wastes were investigated using dilute sodium hydroxide solution and dilute peracetic acid.

C2-16 Hydrogenation of xylose to xylitol. Wisniak, J., Hershkowitz, M., Leibowitz, R., Stein, S. (Univ. Negev, Beer Sheba, Israel) Indus. England Chem. Prod. Res. Developmt. 13(1): 75-79. (1974) Chem. Abs. 80 147141g

Pressure, temperature, catalyst concentration, and agitation effects on hydrogenation of xylose to xylitol were studied by Raney Ni. Followed pseudo first-order reaction.

C2-17 Xylitol production by an *Enterobacter* species. Yoshitaki, J., Ishizaki, H., Shimamura, M., Imai, T. (Godo Shusei Co., Ltd., Matsudo, Japan) Agr. Biol. Chem. 37(10): 2261-2267. (1973) Chem. Abs. 80 13631h

Xylitol production reached a maximum of 33.3 mg/ml after cessation of *E. liquefaciens* growth on a medium containing 10% xylose as the sole C source and did not decrease thereafter.

C2-18 Production of polyalcohols by a *Corynebacterium* species. II. Xylitol production by a *Corynebacterium* species. Yoshitaki, J., Shimamura, M., Imai, T. (Godo Shusei Co., Ltd., Matsudo, Japan) Agr. Biol. Chem. 37(10): 2251-2259. (1973)

Xylitol production by *Corynebacterium* 208 grown on gluconate xylose medium increased as the gluconate concentration increased.

C2-19 Recovery of pentoses and hexoses from wood and other material containing hemicellulose, and further processing of C_5 and C_6 components. Funk, H. F. Appl. Polymer Symposium 28: 145-152. (1975)

The Silvichem process is described. It allows recovery of hemicelluloses, such as pentoses and hexoses, without any damage of the cellulose fiber and without loss of lignin.

C2-20 Acid hydrolysis and dehydration reactions for utilizing plant carbohydrates. Harris, J. F. Appl. Polymer Symposium 28: 131-144. (1975)

A significant amount of information is available for preliminary estimation of the commercial feasibility of processes for utilizing plant carbohydrates based on acid hydrolysis.

C2-21 The hydrothermal degradation of cellulosic matter to sugars and their fermentative conversion to protein. Bobleter, O., Niesner, R., Rohr, M. J. Appl. Polymer Sci. 20(8): 2083-2093. (1976)

Cellulose samples, filter paper, ^{14}C labeled straw, and natural straw were extracted with water at 200°-275° C. The growth curves of *Candida utilis* were studied on the degradation products.

C2-22 The possibility of obtaining furfural from straw essence, and the remains of sugar cane-obtaining of furfural in pilot plants. Milovanov, A., Olguin, Y., Corona, E. ICIDCA (Inst. Cubano Invest. Deriv. Cana. Azucar.) Bol. 3(1): 2-10. (1969) Biol. Abs. 53 138670

Reports results of pilot plant scale production of furfural from bagasse with variations of the process, and the characteristics of the crude furfural obtained.

C2-23 Studies on the chemical degradation of cereal straw using a sodium hydroxide solution. 6. Concurrent ensilage of sodium hydroxide-treated straw and green maize as influencing silage quality, ruminal fermentation, and digestibility. Piatkowski, B., Schmidt, L., Weissbach, F., Voigt, J., Peters, G., Prym, R. (Forschungszent. Tierprod., Daw. Rostock, East Germany) Arch. Tierernaehr. 24(9-10): 701-710. (1974) Chem. Abs. 82 154023

Barley straw treated with 5% NaOH was mixed with maize and ensiled. Maize-to-straw ratios were 100:0, 83:17, 66:34. All silages produced were of very good quality. Excess base intensified acid production and reduced proportion of residual sugar. Thirty-four percent straw was still palatable to cows.

C2-24 Ethanol fermentation and potential. Miller, D. L. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a Chemical and and Energy Resource, John Wiley and Sons, New York, pp. 345-352. (1975)

Discusses the current means of ethyl alcohol production and the feasibility of ethyl alcohol production from cellulose.

C2-25 The prospects for fermentation of alcohol from hydrolyzed cellulose. Finn, R. K. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 345-352. (1975)

Presents a discussion of fermenting alcohol from cellulose and the costs. Gives four references.

C2-26 The acid hydrolysis of refuse. Grethlein, H. E. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 303-318. (1975)

Discusses the methods, results, and costs of acid hydrolysis of refuse, and gives five references.

C2-27 Cellulose as a chemical and energy resource. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose Conference, Univ. Calif., Berkeley. John Wiley and Sons, New York, 361 pp. (1975)

This book contains 34 papers that discuss use of cellulose and cellulose-containing raw materials, such as straw and wood, to produce energy and chemicals.

C2-28 Hydrolysis of annual plants to obtain furfural and complex organic-inorganic fertilizers. Constantinescu, G. C. (Inst. Politekh. "Gheorghe Gheorghiu-Dei", Bucharest, Romania) Bul. Int. Politekh. "Gheorghe Gheorghiu-Dej", Bucuresti 31(3): 41-50. (1969)

A study was made of chemical changes taking place during hydrolysis of straw with 5% H_2SO_4 and H_2O_2 at 70° and 90° C.

C2-29 Furfural and paper pulp from vegetable materials. Dambrine, F., Giorgi, J. C., Frouin, J. (Societe Fives Lille-Cail) Fr. 1,539,107 (Cl. C 07d, D 21c), 13 Sept. 1968, Appl. 01 Aug., 1967, 3 pp.

Furfural and good quality paper pulp were prepared at a normal cooking liquor consumption, from vegetable materials, such as oat, rice straw, corncob, and bagasse.

C2-30 Chemicals from lignocellulose. Goldstein, I. S. Gaden, E. L., Jr. (ed.) Sixth Biotechnol. and Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 293-301. (1976)

The technical aspects of chemicals from lignocellulose are discussed and their conceptual feasibility is demonstrated.

C2-31 Chemicals from cellulose from paper mill primary sludge. Hearon, W. M., Lo, C. F., Witte, J. F. Appl. Polymer Symposium 28: 77-84. (1975)

The oxidation of bleached kraft pulp in H_2O by $NaIO_4$ followed by N_2O_4 gave dialdehyde cellulose and dicarboxy cellulose in 97.7% of theory and with 47% carboxyl content, respectively, and further oxidation, produced tricarboxy cellulose with 67.73% carboxyl content. The hydrolysis of tricarboxy cellulose with H_2SO_3 yielded meso tartaric acid and glyoxalic acid which was converted to glycine by reductive deamination.

C2-32 Modifying wood waste to increase its *in vitro* digestibility. Millett, M. A., Baker, A. J., Feist, W. C., and others. J. Anim. Sci. 31(4): 781.

Although vibratory ball milling is an effective pretreatment, milling response is species selective. Hardwoods ranged from 80% attainable digestibility to 20%; softwoods showed a maximum digestion of only 18%. This type of selective species response severely limits the broad application of milling.

C2-33 Xylitol from natural products containing xylan. Kazama, F. (Towa Kasei Kogyo Co., Ltd.) Japan 1974, 48,288 CCL C07c Boij. 20 Dec. 1974. Appl. 68 8225g 12 Nov. 1968, 2 pp. Chem. Abs. 83 10722q

Xylitol was prepared by treating plant materials containing xylans with a diluted mineral acid, removing the ash, acidifying the aqueous solution, and hydrogenating xylan over a catalyst, Raney Ni, at 150° to 200° C. Thus, a mixture of 120 g cottonseed husk and 450 ml of 0.3% aqueous H_2SO_4 was boiled 30 min and filtered. Twenty g Raney Ni and H_2O were added, and the mixture was acifified to pH 3.2 and hydrogenated in an autoclave at 180° C for 3 hr to give 24.5 g xylitol.

C2-34 Pure xylitol. Deiters, W. (Inventa A-G fuer Forschung und Patentverwertung) Swiss 560 175 (Cl C07c) 27 Mar. 1975. Appl. 8499/71 11 June, 1971, 7 pp. Chem. Abs. 83 10717s

Hydrolysis of corn cobs with 4% H_2SO_4 at 100° C followed by extraction with EtOAc gave -D-xylose, which crystallized from MeOH containing $MgSO_4$. It was then hydrogenated with Ni/Al_2O_3 at 300 atm H to give 75 kg D-xylitol per hour in a continuously operating apparatus with regeneration of solvents and reagents.

C2-35 Xylose and xylitol. Melaja, J. J., Halalainen, L., Heikkila, H. O. (Suomen Sokie, Oy) Ger. Offen. 2,418,800 (CiC 13K C 07c) 14 Nov. 1974. U.S. Appl. 354,391, 25 Apr. 1973, 63 pp. Chem. Abs. 82 73401j

Xylose and xylitol were manufactured from pentose-containing solutions obtained by acid hydrolysis of pentosan-containing material, by successive filtering, deionization, and chromatographic fractionation over a divinyl benzene-crosslinked polystyrene sulfonate cation exchange resin, and optimally followed by catalytic hydrogenation.

C2-36 Xylitol and its derivatives. Anikeeva, A. W., Zarubinskii, G. M. Danilov, S. N. (Inst. Vysolkomol Soedin, Leningrad, U.S.S.R.) Usp. Khim. 45(11): 106-137. (1976) Chem. Abs. 84 123631y

A review with 553 references. The preparation, identification, and uses of xylitol and its derivatives are described.

C2-37 Percolation pentose-hexose hydrolysis of corn stalk cores. Klimova, Z. K., Belenkii, S. I., Vaskevich, T. V., Polyakova, L. P. (U.S.S.R.) Gidioloz Lesokhim. Pram. 1: 19-23. (1974) Chem. Abs. 81 107738w

High yields of pentoses containing xylitol were obtained by hydrolyzing cornstalks in a percolator with H_2SO_4 solution at 80°-100° C for 2 hr. The solution was drained off and the residue was heated at 135° for 20 min in 1% H_2SO_4 solution (The solution volume was twice the residue volume.). The treatment removed $\leq$ 60% of all the solution compounds from the stalks; 92-97% of these were pentosans. On a plant scale, the residue left after the percolation with 1% H_2SO_4 was treated with another portion of 1% H_2SO_4 solution to extract the remaining hexoses. The hydrolysis of corncob stalks took longer than the hydrolysis of cotton hulls, but the yield of pentosans was higher, since their average contents in the stalks was 38.1% versus 28.3% in the cotton hulls.

C2-38 Potential useful products from cellulosic materials. Edwards, V. H. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 321-338. (1975)

Discusses the potential use of cellulosic materials, needs, methods, feasibility, fuels, food and food additives, organic chemicals, and other products.

C2-39 Discussion of potential useful products from cellulosic materials. Davis, H. G. Wilke, C. R. (ed.) Fifth Biotechnol. and Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 339-341. (1975)

Discusses the feasibility of the use of cellulosic materials in the production of fuels, foods, and raw materials for chemicals.

C2-40 Fermentation of waste materials to produce industrial intermediates. Compere, A. L., Griffith, W. L. Oak Ridge Natl. Lab., Tenn., Rpt. No. 18: 17 pp. (1975)

The fermentation of waste materials to methane is currently being considered; however, methane is not a product of choice, because it is worth only about 1¢ per pound. Recovery of a product more valuable than methane is desirable. The fermentation of waste whey to produce lactic acid was demonstrated, using a bench-scale anaerobic upflow packed bed reactor. The lactic acid was recovered using ion exchange techniques. Fermentation-produced acids, which include acetic, proprionic, butyric, succinic, and lactic acids, are worth an order of magnitude more on a weight basis than is methane.

C2-41 Combined conversion of potatoes to alcohol and starch. Yarovenki, V. L., Skalkina, E. P., Pykhova, S. V. Environmental Protection Agency, Research Triangle Park, N. C. Translation Serv. Sect. Rpt. No. 18: EPA-TR-76-174, 10 pp. (1960)

In connection with the increased manufacture of synthetic alcohol, the production lead of alcohol plants based on agricultural raw materials has been reduced recently. At the same time, because of inadequate capacities of starch plants, the production of food starch, nevertheless, lags behind demands. Therefore, the organization of combined conversion of potatoes to alcohol, starch and feed in alcohol plants located in well-developed potato growing regions in one of the most rational and prospective directions in the operation of many alcohol plants. Combined processing of potatoes will make it possible to enormously increase the output of starch, make the most efficient use of the technical and raw material base of alcohol plants, and at the same time, more completely utilize the entire composition of processed potatoes.

C2-42 Manufacture of (L)-arabinose, pectin and cellulose residue from exhausted sugarbeet slices and pulp. Janecek, F., Rendos, F., Tibensky, V. Czechoslovak Patent 1975; 153 378

The slices or pulp are treated with sulphuric acid (0.1-6% concentration) at (greater than or equal) 100° C for 10 min-3 H; the resultant solution is strained and thickened; the pectin is precipitated and filtered off; and the solution is refiltered. (L)-arabinose is obtained by standard techniques; the cellulose-containing residue is washed with water and thickened.

C2-43 Alcohol from cellulose. Gauss, W., Suzuki, S., Takagi, M. (Japan) Ger. Offen. 2541960 (C12CE), 20 Sept. 1974, 7 pp. Chem. Abs. 83 019069

Alcohol was produced from cellulose by reacting cellulose with cellulase from *Trichoderma viride* and subjecting the resultant glucose to anaerobic fermentation with *Saccharomyces cervisiae*. 12.5 g wood pulp, salts, and yeast extracted in 100 ml H_2O was brought to pH 4 with acetate buffer, was sterilized, and was inoculated with *S. cerevisiae* incubated at 30° C to produce 4 g alcohol after 192 hr.

C2-44 Conversion of cellulosic materials to sugar. Wilke, C. R., Mitra, G. U.S. 3972775 (195-33; C12D13/02). 28 June 1974, 6 pp.

Presents a process for sugar production by enzymic hydrolysis of cellulose that allows for recovery and reuse of a major portion of the employed enzyme, and for use of a portion of the product in the production of the microbial cellulase (from *T. viride*) used.

C2-45 Cellulose production. Menzies, J. W. (Univ. Develpmt. Found.) Ger. Offen 1,900,796 (Cl. D 21c), 11 Sept. 1969, U.S. Appl. 09 Jan. 1968, 25 Nov. 1968, 22 pp.

Crude plant material was delignified by treatment with a dilute solution of H_3PO_4 and HNO_3 so that lignin reaction products were formed that were soluble in alkaline solution. Procedure and results are given.

C2-46 Chemical conversion of wood and cellulosic wastes. Shafizadeh, F., McIntyre, C., Lundstrom, H., Fu, Y. L. (Univ. Mont., Missoula) Rpt. No. EPA-670/2-74-015. (1974)

Discusses laboratory methods, utilizing thermal reactions, to convert cellulosic wastes to levoglucosan, levulinic acid, glyoxal, and active carbon.

C2-47 The chemical conversion of solid wastes to useful products. Barbour, J. F., Groner, R. R., Freed, V. H. (Dept. Agr. Chem. Oreg. State Univ., Corvallis) Rpt. No. EPA-670/2-74-027. (1974)

The objectives of this study were to (1) Identify the chemical nature of the constituents of solid waste, (2) investigate transformation processes, and (3) conduct engineering and economic evaluation of pilot plant operations.

D. Biological Conversions

1. Ensiling and Composting

D1-1 Kinetics of rice straw decomposition in soils. Pal, D., Broadbent, F. E. J. Environ. Qual. 4(2): 256-260. (1975)

Mature rice straw was decomposed in Sacramento clay and Stockton adobe clay. Straw had a pronounced effect on loss of soil C, but the effects on soil N were small.

D1-2 Studies on the composition of mushroom compost. Shin, K. C., Kim, G. P., Oh, B. L., Kim, D. S. Res. Rpt. Off. Rural Devlpmt. (Plant Environ.) (Suwon, Korea) 14: 107-118. (1971) Biol. Abs. 55 008160

Compared the yields from 75 different mixtures using five C sources, three N sources, four kinds of organic nutrients--P, K, gypsum, and carbonated Ca. In spring, highest yields were obtained from a combination of rice straw, poultry manure, rice bran, urea, and gypsum; in autumn, best yields came from a combination of rice straw, poultry manure, urea, K, and gypsum.

D1-3 Ammonia fixation of humus substances in arable soils and organic fertilizers. Valdmaa, K. (Agr. Col. Sweden, Uppsala, Sweden) Lantbruks-Hegsk. Ann. 35(2): 199-228. (1969) Chem. Abs. 71 60166j

Tables report the percent clay, pH, percent saturation with Ca, total P, K, organic C, total N, percent methoxyl C of total C, and C/N ratio of 15 samples of soils, including loam, sandy loam, sand, clay, mulch, sewage sludge, farmyard manure, wheat straw, birch sawdust, and pine sawdust. Procedure and results are presented.

D1-4 Phytotoxic components detected in the compost prepared from rice straw with a past history of applications of an organochlorine fungicide. Yukimoto, M., Goto, S., Yoshida, K. Noyaku Kensasho Hokoku No. 10, pp. 62-66 (Japan). (1970) Chem. Abs. 14 140173m

Acidic substances in the test soil and compost were extracted with an acidic acetone and transferred to ether. Identification of the phytotoxic substances was made by methylation and followed by gas chromatography.

D1-5 Turkey litter silage in rations for dairy heifers. Cross, D. L., Jenny, B. F. J. Dairy Sci. 59(5): 919-923. (1976)

Average daily gains for heifers on 15% turkey litter silage were higher than for controls. Data show a potential use for turkey litter silage in dairy heifer rations.

D1-6 Studies on improving the utilization of fodders of poor quality; ensiling wheat straw with cowpea *Vigna sinensis*. Narang, M. P., Pradhan, K. Indian J. Anim. Sci. 44(1): 14-17. (1974)

In comparison to fresh wheat straw, ensiling wheat straw with cowpea improved feed intake, dry matter digestibility, and milk yield in milk cows.

D1-7 The effect of bacteria leaven and an enzyme on the fermentation processes in ensiling alfalfa with wheat straw. Popenko, A. K., Bayakhunov, Y. K. Tr. Inst. Mikrobiol. Virusol. Akad. Nauk. Kaz. Ssr. 16: 70-75. (1970)

Title only translated; no further information.

D1-8 Composting of agricultural waste materials with spent slurry as a starter for decomposition. Laura, R. D., Idnanni, M. A. Indian J. Agr. Sci. 42(3): 246-250. (1972)

Under anaerobic conditions, N-deficient wheat straw and soybean fodder were composted with spent slurry as a source of additional N. Both wheat straw and soybean fodder without spent slurry decomposed 10-15%; whereas, addition of spent slurry caused a loss of 30-40% of dry matter within 45 days.

D1-9 The establishment of some composts for the replacement of horse dung in mushroom culture. Bulboaca, M. Lucr. Sti. Int. Inst. Agron. ´n Balcescu´ Bucur Ser. B 13, pp. 53-61. (1970) Biol. Abs. 53 013656

Best mushroom yields were obtained with 100% horse dung, 50% horse dung with 50% wheat straw, and 50% poultry dung with 50% wheat straw, as compost in growing mushrooms.

D1-10 Thermophilic anaerobic digestion of solid waste for fuel gas production. Cooney, C. L., Wise, D. L. Biotechnol. Bioengin. 17(8): 1119-1136. (1975)

The use of thermophilic (65C) digestion to convert organic solid waste to fuel gas (CH_4) can achieve higher rates of digestion, greater conversion of waste organics to gas, faster solid liquid separation, and minimization of bacterial and viral pathogen accumulation.

D1-11 Kinetics and economics of anaerobic digestion of animal waste. Gaddy, J. L., Park, E. L., Rapp, E. B. Water, Air, Soil Pollut. 3(2): 161-169. (1974)

Animal waste can be converted to CO_2 and CH_4 by the autocatalytic process of anaerobic fermentation. Presents a scheme for disposal from a feed lot, based on kinetic data from literature. The sale of CH_4 gives a 23% per year return on investment.

D1-12 Effect of rice straw compost on the humus substances and microbes of mulberry field soil. Inamatsu, K., Tardieux, M. A., Moussin, M. M., Pochon, J. (Serv. Microbiol. Milieux Nat., Inst. Pasteur. Jouy-en-jossas. Fr.) Rev. Ecol. Biol. Sol. 11(1): 1-14. (1974) Chem. Abs. 83 177251

Application of straw compost increased the content of easily mineralizable humus and the activity of cellulolytic micro-organisms and anaerobic N-fixing bacteria.

D1-13 Solid waste composting. Wiles, C. C., Lefke, L. W. J. Water Pollut. Control Fed. 44(6): 1104-1106. (1972)

A review of the literature on composting with 28 references. Most of the problems are economic--not scientific.

D1-14 Thermophilic anaerobic digestion of cellulosic waste. Cooney, C. L., Ackerman, R. A. Eur. J. Appl. Microbiol. 2(1): 65-72. (1975)

Examines the use of anaerobic digestion for methane production, using shredded newsprint and primary sludge at 55° C. Maximum productivity occurred at a nominal retention time of 5 days while using a total solids feed of 50 g/liter.

D1-15 Biological consequences of plant residue decomposition in soil. Snyder, W. C., Patrick, Z. A., Weinhold, A. R. Rpt. No. EPA-R2-72-107. (1973)

This 7-year study reports on the nature and action of phytotoxic substances that are released to the soil from decomposing plant residue.

D1-16 Gainesville compost plant; final report on a solid waste management demonstration. Volumes I and II. Gainesville Municipal Waste Conversion Authority, Inc., and Environmental Engineering, Inc. Rpt. No. EPA-530/5W-210-73-009. (1973)

A technical and economic evaluation of the Gainesville, Florida, compost plant that operated from 1968 to 1971, and handled 150 tons of municipal solid waste per day.

D1-17 Cellulose degradation in composting. Regan, R., Jeris, J. S., Gasser, R., McCann, K., Hudek, J. (Manhattan Col., Bronx, N. Y.) Rpt. No. EPA-R3-73-029. (1973)

The optimum environmental conditions for the degradation of refuse using the composting process were determined on a laboratory scale. Cellulose, a major component of the paper in refuse, is resistant to biodegradation, and should be recovered rather than composted.

2. Single Cell Protein

D2-1 Preservation of wet yeast for animal feeding. Namory, M. (Cent. Rech. Agron. Antilles Guyane, Inst. Natl. Rech. Agron., Petit-Bourg, Guadeloupe) Ann. Technol. Agr. 24(1): 35-45. (1975) Chem. Abs. 84 042110

HOAc, HCl, $EtCO_2H$, $K_2S_2O_5$, or H_2CO all prevented deterioration of yeast slurry (13% dry matter).

D2-2 Production of single-cell protein by the cultivation of yeast in anaerobic digester supernatant supplemented with carbohydrates. Irgens, R. L., Clarke, J. D. (Dept. Life Sci., Southwest Missouri State Univ., Springfield, Mo.) Eur. J. Appl. Microbiol. 2(4): 231-241. (1976) Chem. Abs. 85 190664

Basal medium, which is suitable for the turbidimetric estimation of the growth of yeasts, was prepared from liquor obtained from the anaerobic digester of a waste treatment plant. The yeast, *Candida utilis*, grew well in the medium when a source of carbohydrate was added.

D2-3 Products of microbiological synthesis in animal nutrition. Tkachev, I. F. (Kuban Agr. Inst., Krasnodar, U.S.S.R.) Biol. Chem. VYZ. Zvirat 11(3): 203-208. (1975) Chem. Abs. 84 042326

Yeasts cultured on alkanes containing 50-55% proteins of 95% digestibility, and high in lysine, were administered to piglets and hens as a protein substitute (10% of the diet protein).

D2-4 Protoplasts of *Cosmarium turpinii* as a potential protein source. Berliner, M. D., Wenc, K. A. Appl. Environ. Microbiol. 32(3): 436-437. (1976)

C. turpinii, a fast-growing desmid alga, transforms into protoplasts in 4 hr when incubated in a mineral medium +0.4 M mannitol + 0.5 cellulysin (hydrolytic enzymes from *Trichoderma viride*). The cell-wall-less algae are more easily digested.

D2-5 Single cell protein from cellulosic wastes. Han, Y. W., Dunlap, C. E., Callihan, C. D. (Div. Engin. Res., La. State Univ., Baton Rouge, La.) Food Technol. 25(2): 32-35, 56. (1971)

Using a symbiotic culture of *Cellulomonas* and *Alcaligenes*, single-cell protein (SCP) was produced from sugarcane bagasse. The cellulosic substrates were pretreated with NaOH and heat. Fermentation was run in batches or continuously, and cell yield of 6.24 g dry cells/liter was obtained. The microbial cells contained 46.2% protein and methionine was the limiting amino acid. This process was thought to be potentially useful for utilization of agricultural wastes.

D2-6 Use of single cell protein as feed in fish farming. Nose, K. (Fresh Water Fish. Res. Inst., Japan) SCP (Single Cell Protein) No Seisan To Riyo, pp. 136-145. (1975) Chem. Abs. 85 092241

Review that discusses characteristics of fish feeds and of paraffin-grown yeasts and other SCP as fish feeds. Contains 23 references.

D2-7 Problems of feed manufacture using single cell protein. Yoshida, M. (Natl. Inst. Anim. Ind., Chiba, Japan) SCP (Single Cell Protein) No Seisan To Riyo, pp. 126-135. (1975) Chem. Abs. 85 092240

Reviews future of SCP, feed value of SCP, effect of SCP on fertility of chicks, and safety of SCP as feed. Contains 37 references.

D2-8 Single cell protein production by basidiomycetes. Sugimor, T. (Marukin Shoyu K. K., Osaka, Japan) SCP (Single Cell Protein) No Seisan To Riyo, pp. 114-118. (1975) Chem. Abs. 85 092131

The possibility of SCP production by edible basidiomycetes is reviewed, and includes nine references.

D2-9 Single cell protein production from spent sulfite liquor. Tsutsui, Y. (Jujo Pap. Mfg. Co., Ltd., Tokyo, Japan) SCP (Single Cell Protein) No Seisan To Riyo, pp. 44-52. (1975) Chem. Abs. 85 092128

This review discusses pulp waste water, production of SCP from pulp waste water, composition and utilization of pulp waste SCP, and economy of sulfite pulp waste water SCP. Gives 30 references.

D2-10 Unconventional protein feed. Poutiainen, E. (Inst. Husb., Univ. Helsinki, Helsinki, Finland) Nord. Jordbrugsforsk. 57(3): 617-621. (1975) Chem. Abs. 83 146057

Feeding experiments with Pekilo protein are discussed.

D2-11 Acid hydrolysis of sunflower seed husks for production of single cell protein. Eklund, E., Hatakka, A., Mustranta, A., Nybergh, P. (Dept. Microbiol., Univ. Helsinki, Helsinki, Finland) Eur. J. Appl. Microbiol. 2(3): 143-152. (1976) Chem. Abs. 85 175551

Sunflower seed husks were chosen as a typical lignocellulosic waste product of low value. This model substrate was hydrolyzed with sulfuric acid at 120° C, neutralized to pH 5 with solid $Ca(OH)_2$ and used for preparation of growth media for *Candida* yeasts and *Paecilomyces variotii*.

D2-12 Microbiological production of protein substances. Eroshin, V. K. (Lab. Mikrobiol. Tekhnol., Inst. Biokhim. Fiziol. Mikroorg., Pushchino, U.S.S.R.) Biokhim. Fiziol. Mikroorg., pp. 5-8. (1975) Chem. Abs. 85 141239

Discusses the high content of proteins in micro-organisms (40-70% of dry weight) as a rich source for nutrition of human populations. Provides six references.

D2-13 Removal of nucleic acids in SCP (single-cell protein). Sinskey, A. J., Tannenbaum, S. R. (Dept. Nutri. Food Sci., Massachusetts Inst. Technol., Cambridge, Mass.) Tannenbaum, S. R., Wang, D. I. C. (ed.) Single Cell Protein II, MIT Press, Cambridge, Mass., pp. 158-178. (1975)

Reviews present methods for removal of nucleic acids from SCP, and advantages and disadvantages of each method. Includes 14 references.

D2-14 Single cell proteins from cellulosic wastes. Bellamy, W. D. Biotechnol. Bioengin. 16(1): 869-880. (1974)

SCP from fermentation of petroleum and cellulosic wastes are likely sources of additional protein to meet present and projected needs for protein. There is adequate cellulose. Biodegradation of lignin and lignin-cellulose complexes are a major obstacle to commercial utilization of cellulosic wastes. Thermophilic actinomycetes appear to be the most effective organisms for SCP production from cellulosic wastes.

D2-15 Bacterial protein production from cellulose. I. Effect of mineral composition of the nutrient medium on bacterial utilization of cellulose. Schmid, S., Bomar, M. T. (Bundesforschungsanstalt Fuer Ernaehrung, Engesserstrasse 20, D-75 Karlsruhe, Fed. Repub. Germany) Alimenta 14(6): 185-189. (1975) 76 05 G0297 Food Sci. and Technol. Abs.

The production of SCP on a cellulose substrate by *Cellulomonas* strain S 1/47 and 10/73 (nonspore forming rods) was studied, with special attention given to the composition of trace element supplements. A supplement containing 0.12 ppm Cu in addition to Fe, Mn, Co, Mo, and Zn increased SCP production over that on the basic medium from 64 to 89 mg/g cellulose for strain 1/74, and from 36 to 160 mg/g for 10/73, with corresponding increases in cellulose decomposition from 15.6 to 34% and from 17.5 to 66%.

D2-16 Bacterial protein production from cellulose. II. Effect of individual trace elements on cellulose fermentation. Schmid, S., Bomar, M. T. (Bundesforschungsanstalt Fuer Ernaehrung, Engesserstrasse 20, D-75 Karlsruhe, Fed. Repub. Germany) Alimenta 14(6): 191-194. (1975) 76 05 G0298 Food Sci. and Technol. Abs.

Investigated the effect of individual trace elements Mn, Fe, Cu, Zn, Mo, and Co on pH, cellulose decomposition, and biomass production during aerobic bacterial fermentation of cellulose. By all three criteria, only Mn was found to be essential. Supplementation of the basic medium with all trace elements, except Mn, gave lower results than no supplement, while Mn supplement without the other trace elements gave results similar to the complete supplement. Cellulose fermentation was even more affected by Mg--exclusion of Mg from the basic medium completely inhibited cellulose decomposition.

D2-17 Manufacture of yeast biomass from whey. Mergl, M., Uher, J. (Vyzkumny Ustav Miekarensky, Prague, Czechosolovakia) Prumsyl Potravin 26(10): 475-477. (1975)

Whey, preferably deproteinized, was fermented in a laboratory and semi-production fermenter (5,000 liter capacity), using ethanol as the carbon and energy source, plus mineral and ammonia supplements. *Candida utilis* 49 adapted to ethanol was used as the fermenting organism in a single-stage process lasting 14-15 hr, that produced a liquor with 11-13% DM (6-8% biomass DM) which was then concentrated by evaporation and dried. The dried product contained 93.5% DM, 26.2% nitrogenous substances (N X 6.25), 5.5% fat, 10.5% ash, and 71.2% extractable nonnitrogen compounds.

D2-18 Effect of carbon sources on properties of single cell protein and energy efficiency of its production. Masuyama, K. (Cornell Univ., Ithaca, New York) Diss. Abs. Internatl., B 36(6): 2699. (1975)

Studied effects of the C sources on physical and chemical properties of SCP. A mixed culture of *Candida tropicalis* and *C. lipolytica* gave higher yield and faster growth rate than individual cultures on the substrate studied. Thermodynamic analysis of protein production showed that SCP production was more energy-efficient than animal protein production.

D2-19 Economics of producing nutrients from cellulose. Dunlap, C. E. Food Technol. 29(12): 62, 64-67. (1975)

Discusses several processes being developed to produce a food- or feed-quality carbohydrate or protein concentrate from cellulose. These processes center on producing glucose in solid or syrup form, or SCP as a protein concentrate. Stresses the importance of keeping the nutritional products produced from cellulose competitive in cost and use with conventional products. Includes tables and bar graphs comparing production methods, cost, and yields.

D2-20 Single-cell protein production by photosynthetic bacteria cultivation in agricultural by-products. Shipman, R. H., Kao, I. C., Fan, L. T. (Dept. Chem. Engin., Kansas State Univ., Manhattan, Kansas) Biotech. and Bioengin. 17(11): 1561-1570. (1975)

Investigated growth of the nonsulphur photosynthetic bacterium *Rhodopseudomonas gelatinosa* on various agricultural byproducts such as corn starch, potato starch wastes, molasses and wheat bran. Wheat bran was chosen as a substrate for mass culture and continuous-cultivation studies. Harvested photosynthetic cells contained approximately 65% crude protein and 5.1% nucleic acid (RNA). The amino acid content of harvested photosynthetic proteins was comparable to conventional proteins of plant and animal origin.

D2-21 The economics of single cell protein production. Ratledge, C. (Dept. Biochem., Univ. Hull, Hull, England) Chemistry and Industry 21: 918-920. (1975) Chem. Abs. 84 015726

Processes for production of SCP based on alkanes and other substrates are discussed in economic terms. SCP will be competing primarily with soybeans, and SCP cost is largely governed by the cost of substrate--often a cheap or waste material. Quality, acceptability, and cost are mentioned.

D2-22 Single cell protein for human food. Lovland, J., Harper, J. M., Frey, A. L. (Norwegian Inst. Technol. N-7034 Trondheim-Nth., Norway) Lebensmetl.-Wiss. u. -Technol. 9(3): 131-142. (1976) Chem. Abs. 85 175636

The purpose of this paper was to review the present status of SCP as a food. Topics covered include current development work; the nutritive value, safety, and palatability of SCP; and various processing aspects including removal of nucleic acids, cell disruption, protein concentration and processing, or functional properties.

D2-23 Microbial cells for food. Litchfield, J. H. Battelle, Columbus Lab., Columbus, Ohio. Abs. of Papers, Amer. Chem. Soc. 171 (Centennial). (1976)

Over the last decade, research has been directed toward development of processes for aerobic production of bacterial and yeast cells, fungal mycelium from methane and N-paraffin hydrocarbons, petrochemicals from ethanol and methanol; and utilization of cellulosic materials and agricultural wastes and byproducts for food or feed use. Mushroom mycelium has been produced and sold as a food-flavor additive. With the exception of primary food- or feed-yeast produced from molasses, sulfite-waste liquor, or cheese whey, none of the other microbial products are as yet available on a significant commercial scale. The future of microbial cells as food or feed will depend upon their ability to compete with established animal and plant products on the basis of price, nutritional quality, and functional use.

D2-24 Effects of feeding Pekilo single cell protein in various concentrations to growing pigs. Farstad, L., Liven, E., Flatlandsmo, K., Naess, B. (Dept. Microbiol. Immunol., Vet. Col. Norway, Oslo, Norway) Acta. Agr. Scand. 25(4): 291-300. (1975) 76 05 50734 Food Soc. and Technol. Abs.

Twenty-four weaned Norwegian Landrace swine were used in a 106-day feeding trial to evaluate Pekilo SCP. Results show that the carcass quality of swine receiving Pekilo protein was significantly lower than that of the other groups.

D2-25 Use of a thermophilic actinomycete for the production of microbial protein from lignocellulosic wastes. Crawford, D. L. (Dept. Biol., George Mason Univ., Fairfax, Va.) Abs. of Papers, Amer. Chem. Soc., 169. (1975)

A thermophilic actinomycete, *Thermonospora fusca*, which utilizes lignocellulose as a C and energy source, is proposed for use in converting lignocellulosic wastes into microbial protein. This organism rapidly metabolizes lignocellulosic substrates that contain 10% lignin, and significantly degrades substrates containing 18% lignin.

D2-26 By-product recovery from food wastes by microbial protein production. James, A., Addyman, C. L. (United Kingdom, Inst. of Water Pollut. Control Symposium, Dept. of Civil Engin., Univ. Newcastle Upon Tyne, Northumberland, United Kingdom), pp. 149-155. (1974)

Briefly describes the technology of microbial protein production from molasses, whey, and starch. Production achieved is 100 kg yeast dry matter containing 50% protein/400 kg molasses with added aqueous ammonia, $(NH_4)_2SO_4$ and $(NH_4)H_2PO_3$, 2220 kg yeast/82,000 kg whey/day (0.191 kg yeast/kg lactose) and 60% dry weight of available starch with a product containing 40% crude protein. Future possibilities are discussed, with particular emphasis on the economics of protein production.

D2-27 Use of bagasse for the production of bacterial biomass. III. Chemical composition of cellulolytic bacterial of the genus *Cellulomonas*, obtained from cellulosic materials. Osman, G. H., Bell, A., Quintana, M. (Esc. Bioquim. Farm., Univ. Habana, Havana, Cuba) Ciencias, Ser. 5, 10, 13 pp. (1974)

The chemical composition of *Cellulomonas* sp. II grown on sugarcane bagasse was determined. Protein was 27-33%, and nucleic acid content was 9-14%.

D2-28 Fabrication of single cell protein from cellulosic wastes. Daly, W. H., Ruiz, L. P. (Dept. Chem., La. State Univ., Baton Rouge, La.) NTIS, PB Rpt. 1975, 66 pp. (No. 239502/BGA)

The use of several reported chemical additives to cause the cells to flocculate, which enables them to be removed from the fermentation media by a desludging centrifuge, offers an inexpensive method of cell harvesting. The addition of food-grade proteins, followed by a pH adjustment, is an alternative to chemical flocculation. Acid- and alkaline-hydrolysis to remove nucleic acids was investigated.

D2-29 Cultivation of *Candida tropicalis* K-41 on blue-green algae hydrolysates. Shcholokova, I. P., Stohnii, I. P., Ostapchenko, T. P., Petrova, L. A., Kvasnikov, Ye. I. Mikrobiol. Zh. (Kiev) 37(3): 2980302. (1975) Biol. Abs. 62 086812

The possibility of growing fodder yeast *C. tropicalis* on blue-green algae hydrolysates was studied. The concentration of reducing substances in the initial hydrolysates and coefficient of the medium dilution essentially affect the yeast yield. The economic coefficient of these hydrolysates reaches 100%, due to the presence of N-containing substances. The yeasts are fully valuable with respect to biochemical composition.

D2-30 Fungal protein from corn waste effluents a model study. Schellart, J. A. Meded. Landbouwhoogesch. Wageningen 75(17): 1-105. (1975) Biol. Abs. 62 031191

Studied the microbiological aspects of the production of SCP from corn-waste effluents with the reduction of COD of those effluents. A model of corn-steel liquor and glucose, and tap water, was used with *Trichoderma viride* as model organism because of high content of starch and low COD level. The costs of separation of the biomass increased at decreasing concentration of micro-organisms. Fungi were easier to separate because of fungal mycelium.

D2-31 Effect of the chemical nature of the carbon source on biomass composition. Osovik, A. N., Grindina, L. E., Guemenyuk, G. D., Burtsev, V. Ya., Lavrova, I. P., Osovik, E. M. Prikl. Biokhim. Mikrobiol. 11(5): 645-648. (1975) Biol. Abs. 62 031199

Candida tropicalis, *C. utilis*, and *Trichosporon cutaneum* were cultivated on a synthetic medium with addition of B-group vitamins and glucose, glycerol, or lactic acid as the sole C source. The C source affected protein, amino acid composition, nucleic acid, and B vitamins.

D2-32 Reduction of the nucleic acid content of single cell protein concentrates. Hedenskog, G., Ebbinghaus, L. Biotechnol. Bioengin. 14(3): 447-457. (1972)

Suggests a process with precipitation at alkaline pH for the production of microbial protein concentrate from disintegrated yeast and micro-algae with a low content of nucleic acid.

D2-33 Production of fungal protein from cellulose and waste cellulosics. Roger, D. J., Coleman, E., Spino, D. F., Purcell, T. C., Scarpino, P. V. Environ. Sci. Technol. 6(8): 715-719. (1972)

Fungal protein was produced by fermentation of waste cellulosic substrates. Besides its high-quality protein content, *Aspergillus fumigatus* readily degraded cellulose. Various processes to increase the susceptibility of cellulose to biodegradation such as alkali treatment, electron irradiation, photochemical treatment, and hydrolysis were studied. Only photochemical treatment proved significant.

D2-34 Single-cell protein from by-products of malting and brewing. Pomeranz, Y. (U.S. Grain Mark. Res. Center, Agr. Res. Serv., Manhattan, Kans.)

A review with 72 references; no further information.

D2-35 Pekilo, new microbial protein product for use in the feeding of pigs and poultry. Forss, K. (Finn. Pulp Pap. Res. Inst., Helsinki, Finland) Symposium New Develpmt. Provis. Amino Acids Diets Pigs Poult., (Proc.) 1973, 2(ECE/AGRI/4) 2 40-50, 00 000 1972. Chem. Abs. 83 205076

In feeding trials with growing chickens, pigs, and laying hens, Pekilo could replace most or all of the fish meal or powdered skim milk in the practical-type rations without deleterious effect. Pekilo is a microbial protein formed by microfungi cultivated continuously in submerged culture in sulfite liquor. It contains 57-63% crude protein, 2-4% fat, 5-6% ash, 5% H_2O, and abundant B-vitamins, but no antibiotic.

D2-36 Utilization of agricultural and industrial wastes by cultivation of yeasts. Wiken, T. O. (Microbiol. Lab., Univ. Technol., Delft, Netherlands) Terui, G. (ed.) Fermentation Technol. Today, Soc. of Fermentation Technol., Osaka, Japan, pp. 569-576. (1972)

This paper deals with three processes that illustrate the application of yeasts for the purification of agricultural and industrial wastes with the simultaneous production of a biomass of potential economic interest. Describes the Symba process, the DSM-oxanone water process and the manufacture of DGI-yeast protein powder.

D2-37 Proteins from waste cellulose. Callihan, C. D., Irwin, G. H., Clemmer, J. E., Hargrove, O. W. Appl. Polymer Symposium 28: 189-196. (1975)

The organic base for chemicals and other products can be changed from nonrenewable hydrocarbons to cellulose, which is perpetually renewed by photosynthesis. The process of converting bagasse (a cellulosic waste) into protein is described.

D2-38 Production of *Candida utilis* from rye grass straw hydrolysate. Heimsch, R. C., Vedamuthu, E. R., Lekprayoon, C., Anderson, A. W. Abs. Ann. Mtg. Amer. Soc. Microbiol. 72: 15. (1972)

Describes the process of growing *Candida utilis* on ryegrass straw hydrolyzate.

D2-39 Production of single cell protein from cassava by a thermophilic amylase producing strain of *Aspergillus*. Reade, A. E., Gregory, K. F., Khor, G. L., Alexander, J. C. Abs. Ann. Mtg. Amer. Soc. Microbiol. 74: 3. (1974)

Aspergillus, a thermophilic amylase-producing species, was grown on cassava to produce SCP, which was readily accepted by rats.

D2-40 Production of single cell protein from agricultural and food processing wastes to produce microbial protein suitable for animal feeds. Righelato, R. C., Imrie, F. K. E., Vlitos, A. J. J. Wash. Acad. Sci. 66(1): 257-269. (1976)

A process has been developed in which carbohydrate wastes are fermented to produce microbial protein suitable for animal feeds. The process consists of a waste preparation step; growth of a filamentous mold in submerged culture at a low pH; and recovery of the mold by filtration, drying, and bagging.

D2-41 The growth of microfungi on carbohydrates. Anderson, C., Longton, J., Maddix, D., Scammell, G. W., Solomons, G. L. (RHM Res. Ltd., The Lord Rank Res. Centre, High Wycombe, Buckinghamshire, England) Tannenbaum, S. R., Wang, D. I. C. (ed.) Single Cell Protein II, MIT Press, Cambridge, Mass., pp. 314-329. (1975)

Discusses how the growth rate of microfungi varies with carbohydrate substrate and how α-amino nitrogen, rather than total nitrogen, is a better measure of protein content.

D2-42 Substrate for producing fodder yeasts. Chudakov, M. I., Voropaev, I. S., Ivanov, S. V., Antipova, A. V., Samsonova, A. P., Martynenki, K. D. (All-Union Sci. Res. Inst. of the Hydrolysis of Plant Materials) U.S.S.R. 229,407 (Cl. C 12K), 23 Oct. 1968, Appl. 12 Aug. 1967. Izobret., Prom. Obraztsy, Tovarnye Znaki 45(33): 18. (1968) Chem. Abs. 70 P66814v

Food substrate is prepared from plant wastes, such as straw, husks, peat, and wood pulp, by destruction under high temperature and pressure.

D2-43 Animal feeding trials with a microfungal protein. Duthie, I. F. (Dept. of Nutr., The Lord Rank Res. Centre, RHM Res. Ltd., High Wycombe, Buckinghamshire, England) Tannenbaum, S. R., Wang, D. I. C. (eds.) Single Cell Protein II. MIT Press, Cambridge, Mass., pp. 505-544. (1975)

The objective of this program was to develop SCP for human consumption from microfungi grown on carbohydrate. *Penicillum notatum* (*chrysogenum*) was used at first, but discarded in favor of *Fusarium graminearum*. Exhaustive feeding and clinical studies--so far satisfactory--were done on rats, chickens, and baboons. Human testing will be next.

D2-44 Waste cellulose as an energy source for animal protein production feed. Dyer, I. A., Riquelme, E., Baribo, L., Couch, B. V. (Food and Agr. Organ. of the U.N.) World Anim. Rev. 15: 39-43. (1975)

In feedlot trials, steers fed 70% degraded wood gained 0.59 kg/day compared to 1.07 kg by steers fed 70% barley. Additional treatment to remove lignin was necessary to produce a product as good as barley.

D2-45 The Pekilo process: Protein from spent sulfite liquor. Ronantschuk, H. (Oy Tampella Ab, Tampere, Finland) Tannenbaum, S. R., Wang, D. I. C. (eds.) Single Cell Protein II, MIT Press, Cambridge, Mass., pp. 344-356. (1975)

Shows a block diagram of the Pekilo process for producing protein from spent sulfite liquor, and gives tables of the chemical analyses of the sulfite liquor and the final product, Pekilo protein. Graphs of the results of feeding trials on pigs, chickens, and calves are also shown.

D2-46 Single-cell protein form agricultural wastes into protein feeds for pigs and poultry. Imrie, F. New Sci. (London) 66(950): 458-460. (1975)

Describes the formation of single-cell protein from carbohydrate plant material through micro-organisms and the possibilities of deriving human food therefrom.

D2-47 The production of fungal protein from carob in Cyprus. Imrie, F. K. E. J. Sci. Food Agr. 24(5): 639. (1973)

A process suitable for the conversion of carob and other agricultural wastes into biomass for use in animal feeds has been developed on a pilot scale by using an *Aspergillus niger* strain.

D2-48 Single cell protein production from the waste of food processing in Europe. Kato, K. (Natl. Food Res. Inst., Tokyo, Japan) Shokuhin Kogyo 18(4): 36-42. (1975) Chem. Abs. 84 119932

The essential amino acid patterns of various fungi are presented after use in various processes for recovery of resources from food industry wastes (the Symba (Swedish Sugar Co.), Rank-Hovis-McDougal microprotein, and Louisiana State University-Bechtel project process).

D2-49 Recent single cell protein production plants. Kurosawa, K. (Mitsubishi Kakoki Kaisha, Ltd., Japan) Sekiu To Sekiyu Kagaku 19(10): 26-32. (1975) Chem. Abs. 84 072659

A review with six references.

D2-50 Single-cell protein. Overview. MacLaren, D. D. (Exxon Enterp., New York, N.Y.) Chem. Technol. 5(10): 594-597. (1975)

The economic factors that affect commercial single-cell protein production are reviewed. Gives 24 references.

D2-51 Cultivation of single-cell proteins for food with simultaneous recovery of active substances from the residual waters. Muller, H. (Switzerland) Fr. Demande 2275553 (C12D13/06), 21 June 1974, 5 pp. Chem. Abs. 85 076368

Yeast *Hansenula polymorpha* were cultured, and cells were removed by centrifugation. The proteins were removed from the supernatant by ultrafiltration, isoelectric precipitation or solvent extraction. The remaining supernatant can be disposed of with less pollution or can be used as a source of biologically active compounds like plant-growth regulators and biotin.

D2-52 Utilization of cane and coffee processing by-products as microbial protein substrates. Rolz, C. Tannenbaum, S. R., Wang, D. I. C. (eds.) Single Cell Protein II, MIT Press, Cambridge, Mass., pp. 273-313. (1975)

Discusses the production of microbial protein from coffee and sugarcane byproducts in Central America. Yeast from molasses, fungi from coffee wastewaters, and cellulases from bagasse degradation are discussed in detail.

D2-53 Cultivation of fodder yeasts in straw prehydrolyzates. Shamis, D. L., Denisenko, L. E. Tr. Inst. Mikrobiol. Virusol., Akad. Nauk Raz. SSR 11: 25-29. (1968) Chem. Abs. 69 50966q

Two strains of *Candida tropicalis* were selected for the production of fodder yeast on straw hydrolyzates. The wheat or barley straw was boiled 4 hr with 0.5% HCl. The lignin was filtered, the pH adjusted to 5-5.5 with $Ca(OH)_2$ at 70-80% and left for 12 hr. After decantation and removal of the furfural by aeration at 80° C, the hydrolyzates were supplemented with 0.056 g N and 0.036 g P (as P_2O_5) for each gram of reducing value. The yeasts were grown at 30°-37° C and pH 5-5.5.

D2-54 Fungi as protein for food use. Spicer, A. (The Lord Rank Research Centre, High Wycombe, Buckinghamshire, United Kingdom) Proc. Internatl. Symposium on Conversion and Manufacture of Foodstuffs by Micro-organisms, Kyoto, Japan, 1971. Saikon Publishing Co., pp. 227-228. (1972)

Author feels that fungal protein will help solve the world's food shortage problems because it can be produced locally and can easily, because of its filamentous nature, be made into food products. Animal tests have shown no carcinogenic or teratogenic properties.

D2-55 The potential of single cell protein for animal feed. Tolan, A., Hearne, J. F. (Minist. Agr., Fish. Food, London, England) Proc. Conf. Anim. Feeds Trop. Subtrop. Origin, pp. 59-64. (1975)

A review with 17 references emphasizing the nutritional value of the title proteins.

D2-56 Mycelium of edible mushroom grown on noncarbohydrate organic substances, especially on ethanol, as protein for food use. Sugimori, T. (Kyoto Research Laboratories, Marukin Shoyu Co., Ltd., Uji, Kyoto, Japan) Proc. Internatl. Symposium on Conversion and Manufacture of Foodstuffs by Micro-organisms. Kyoto, Japan, 1971 Saikon Publishing Co., pp. 227-228. (1972)

Three kinds of mushrooms, *Lentinus edodes*, *Pleurotus ostreatus*, and *Schizophyllum* sp., were grown on 2% ethanol as carbon source. States that these mushrooms and ethanol, have been used for human food for hundreds of years so they are obviously not toxic.

D2-57 Feed yeast fermentation on sugar sorghum. Varga, L., Sarkany, I. (Szeszipari Kut. Intez., Budapest, Hungary) Szeszipar 23(3): 99-104. (1975) Chem. Abs. 84 072627

Sugar, sorghum juice, or molasses was used as a substrate for feed yeast (*Torula utilis* or *Saccharomyces cerevisiae*). An intensive-aeration fermenter was compared to a static aeration fermenter.

D2-58 Single cell protein II. Mass. Instit. Technol. Press, Cambridge, Mass., 707 pp. (1975) Tannenbaum, S. R., Wang, D. I. C. (eds.)

A compilation of 35 papers presented at the International Conference on SCP at MIT in 1973. It includes bibliographical references.

D2-59 Studies of the utilization of coconut water waste for the production of the food yeast *Saccharomyces fragilis*. Smith, M. E., Bull, A. T. (Biol. Lab., Univ. Kent, Canterbury Kent, United Kingdom) J. of Appl. Bact. 41(1): 81-95. (1976)

The accepted food yeast *S. fragilis* was grown in batch and chemostat culture on coconut water, and on a simulated coconut-water medium, containing glucose, fructose, sucrose and sorbitol, to provide kinetic data for a feasibility study of microbial protein production. Analyses of growth on individual and mixed C substrates were made to determine sugar assimilation.

D2-60 Some protein problems and the importance of fermentation in protein production. Szechenyi, E. (Koezp. Elelmiszeripari Kutatoint., Budapest, Hungary) Elelmezesi Ipar, 29(4): 97-102. (1975) 76 02 G0090 Food Sci. and Technol. Abs.

The nutritional significance of SCP is discussed. In experiments on growth of various yeasts, total content of essential amino acid/100 g protein were: 41.8 g, *Candida utilis* grown on molasses; 43.6 g, *Candida utilis* grown on maize; 44.1 g, *Saccharomyces fragilis* grown on fat; and 45.0 g, *S. lactis* grown on whey. The detailed amino acid composition of various yeasts and foods is tabulated.

D2-61 The nutritive value for growing pigs of single cell protein *Candida utilis* produced from sulfite spent liquor. Brenne, T., Naess, B., Farstad, L. Acta. Agr. Scand. 24(1): 3-6. (1975) Biol. Abs. 59 017791

A control group of pigs received a diet of soybean meal, cereals, and fish meal, while two other groups received half or all digestible protein as SCP. Control pigs gained more than experimental animals, and had higher feed efficiency.

D2-62 Techniques for selection and evaluation of cultures for biomass production. Johnson, M. J. (Col. Agr. Life Sci., Univ. Wis., Madison) Terui, G. (ed.) Fermentation Technol. Today, Soc. Fermentation Technol., Osaka, Japan, pp. 473-477. (1972)

Microbial cells grown for animal feed are preferably produced on a medium containing no organic compounds other than the C source. The culture should be capable of growth on continuous culture under conditions where contaminants will be diluted out. When selection is by continuous enrichment culture, the selected organisms should resist contamination. Measurement of growth rate is essential. When turbidity determination is inconvenient, growth may be followed by monitoring the disappearance of a substrate such as O, C source, NH_3, or phosphate.

D2-63 Production of biomass with the use of microbiological processes on various substrates. Lorkiewicz, Z. Kosmos (Warsaw, Ser. A 24(4): 321-334. (L975) Chem. Abs. 84 41881

A review of protein content of some micro-organisms, substrates used for biomass production, chemical composition, nutritional value of the biomass, and N-fixing micro-organisms in relation to protein production by micro-organisms.

D2-64 Conversion of organic solid wastes into yeasts, an economic evaluation. Meller, F. H. Public Health Serv. Pub. No. 1909. (1969)

Examines the economic feasibility of converting urban and agricultural solid wastes to edible protein by means of acid hydrolysis and subsequent fermentation by *Candida utilis*.

D2-65 Utilization of fibrous wastes as sources of nutrients. Leatherwood, J. M. (Dept. Anim. Sci., N. C. State Univ., Raleigh) Rpt. No. EPA-670/2-73-090. (1973)

Efforts toward development of a fermentor for the growth of an anaerobic celluloytic bacteria that would convert natural cellulosic wastes to nutrients for animals were not successful because the yield of bacterial cells and other products was too low.

3. Microbial and Enzymatic Processes

D3-1 Utilization of cellulosic materials through enzymic hydrolysis. I. Fermentation of hydrolysate to ethanol and single-cell protein. Cysewski, G. R., Wilke, C. R. (Lawrence Berkeley Lab., Univ. Calif., Berkeley) Biotechnol. Bioengin. 18(9): 1297-1313. (1976)

In long-term continuous culture with *Saccharomyces cerevisiae* ATCC 4126, maximum EtOH production occurred at 0.07 mm Hg O tension and 10% glucose feed concentration. A preliminary process design, developed for industrial scale fermentations to produce 24,000 gal/day of 95% EtOH, and torula yeast from sugars obtained by enzymic hydrolysis of newsprint required a total fixed capital of $\$5.37 \times 10^6$. Before EtOH fermentation process improvements and optimization become of equal importance to sugar costs, the base sugar cost must be reduced to 2-3¢/lb.

D3-2 Growth of *Candida utilis* on chemical, microbial, and enzymatic hydrolysates of swine waste. Savage, J. (Rutgers Univ., New Brunswick, N. J.) Diss. Abs. Internatl., B. 35(10): 5015. (1975)

Fermentation of swine waste by various micro-organisms was studied on a laboratory scale as a means of converting waste to single-cell protein. The waste consisted of 80% water and 20% undigestible matter, including large polysaccharide biopolymers. Chemical, physical, and enzymic methods were investigated for degrading these polymers to monomeric units assimilable by *C. utilis*. A mixed culture fermentation of *C. utilis* and polymer-degrading organisms (*Trichoderma viride* QM-9123, *Coriolus versicolor*, *C. hirsutus*, *Poria subacida*, *Myrothecium verrucaria*, and eight *Streptomyces isolates*) showed the best results.

D3-3 Preliminary cost analyses for enzymatic hydrolysis of newsprint. Wilke, C. R., Yang, R. D., Von Stockar, U. (Lawrence Berkeley Lab., Univ. Calif., Berkeley) Rpt. No. 18, Conf-750992-2, 44 pp. W-7405-Engin.-48 (1975)

A tentative process for enzymatic treatment of newsprint with *T. viride* cellulase is presented. Results of a preliminary experiment for enzyme production by recycled cells are used as a basis for the process design. Although cost analyses suggest that it should be feasible to produce sugars in this manner, additional basic research and pilot plant studies will be needed to develop the method to the point of large-scale industrial application.

D3-4 Enzymatic saccharification of cellulose. Ghose, T. K. (Dept. of the Army, Wash., D.C.) Patent-3 642 580, 5 pp. (1972)

This invention relates to a novel process for the rapid and complete hydrolysis of cellulose into glucose, cellobiose, and other simple sugars; and for the separation of the sugar products free of the other reactants. A method of enzymatically converting cellulose to simple sugars wherein finely divided dry cellulose--less than 150 micron particle size--is combined with a concentrated cellulase enzyme solution obtained from *Trichoderma viride* QM 9123 to form a slurry having a cellulose-solids content of 10 to 30%. After hydrolysis, the soluble sugar components are removed by pressure filtration through a molecular sieve membrane without any enzyme passing into the effluent.

D3-5 Release of water soluble compounds in the breakdown of straw by *Basidiomycetes* as a basis for its biological utilization. Zadrazil, F. Zeitschrift Fuer Acker u. Pflanzenbau 142(1): 44-52. (1976) Biol. Abs. 62 11257

The production of edible fungi and extracts of high food value from straw was investigated. Release of glucose and water-soluble compounds (such as amino acids and vitamins) was studied during growth of *Pleurotus ostreatus*, *P. eryngii*, *Agracybe aergerita*, and *Flammulina velutipes* on wheat straw. Soluble sugar concentration increased with fungal growth in order of the above species. About 20% of the substrate could be extracted at 60-70° C (or 40-48% with dilute acid or alkali at 121° C) and concentrated for further food use.

D3-6 Use of cellulose-rich raw materials as substrates for protein biosynthesis. Szebiotko, K., Grajek, W., Piasecki, M., Kubzdela, Z. (Inst. Tech. Zywnosci Pochodzenia Roslinnego Akademii Rolniczef W. Poznaniu, Poland) Prezmysl Fermentacyjny I Rolny 19(1): 4-8. (1975) 75 09 G0576 FSTA

The main source of saccharides is cereal straw, but profitability of processing the material is affected by preliminary processing. Further research is required on the optimal method of preparing the substrate for biosynthesis, and a search for other strains having a high ability to use cellulose as a source of energy is required. One-hundred and twenty-thousand tons of proteins can be obtained from Polish raw materials. *Cellulomonas* bacteria are highly suitable for this purpose.

D3-7 Enzymic degradation of carbohydrates by higher fungi. Bezanger-Beauquesne, L., Didry, N., Lofficial, A. (Lab. Mat. Med., Faculty Pharm., Lille, France) Bul. Soc. Pharm. Lille 31(2-3): 127-147. (1975)

The 43 species of higher fungi that were studied revealed enzymic equipment for most of the carbohydrate substrates selected: Trehalase, invertase, amylase, mannoglucosidases, pectinases, carbohydrases-attacking gums, and unusual cellulases.

D3-8 Production and uses of cellulase enzymes. Brown, D. E. (Dept. Chem. Engin., Univ. Manchester Inst. Sci. Technol., Manchester, England) Octagon Paper 3: 1-15. (1976)

Reviews the production of cellulase enzyme as part of the development of processes for the enzymic hydrolysis of cellulose. Includes 41 references.

D3-9 Fertilizers and animal feed from molasses fermentation residues. Bass, H. H. So. African 74 05900 (C05F), 19 pp. (1973) Chem. Abs. 84 088671

Molasses fermentation residues are treated to obtain products useful as organic fertilizers and (or) animal-feed supplements.

D3-10 Enzymic saccharification of bagasse. Mukhopadhyay, S. M., Ghosh, P., Potty, V. H. (Biochem. Engin. Food Technol. Dept., HBTI, Kanpur, Uttar Pradesh, India) J. Food Sci. Technol., India 12(3): 120-123. (1975) 76 04 60207 FSTA

Investigations of the enzymic saccharification of bagasse, a cellulosic waste from the sugarcane industry, were made. Cellulase in the culture filtrate from *Trichoderma viride* QM 6A caused saccharification.

D3-11 Fungal protein from corn waste effluents. A model study. Schellart, J. A. (Dept. Microbiol., Agr. Univ., Wageningen, Netherlands) No. 75-17, 105 pp. (1975) 76 04 G0257 FSTA

Studied microbiological aspects of the production of microbial, single-cell protein (SCP) from corn-waste effluents, and a simultaneous reduction in the COD of these effluents. The model used was diluted corn-steep liquor with added C source (usually glucose), on which the fungus *Trichoderma viride* was cultivated.

D3-12 Dietary effects of fermented rice hull for the partial replacement of growing-finishing swine ration. Kim, C. S., Han, I. K., Yoon, D. J. (Korea Inst. of Sci. Technol., Korea) Korean J. Anim. Sci. 17(2): 149-154. (1975) 76 11 52022 FSTA

Twenty-five Landrace Yorkshire growing-finishing swine were used in a study on effects of diets containing fermented rice hulls for performance and carcass quality. Five diets were tested: (I) A commercial finishing diet used as the control; diets containing (II) 25%, (III) 50% or (IV) 75% fermented rice hulls; and (V) a diet containing 50% non-fermented rice hulls. (I) gave the heaviest and (IV) the lightest carcasses. Pigs fed (III) had the thinnest and those fed (IV) the thickest backfat. (III) Carcasses were graded 'Excellent' (I), (II) and ((V) carcasses were graded 'good', and (IV) carcasses were graded 'poor'.

D3-13 Protein from cellulose. Bomar, M. T., Schmid. S. Aliment. 14(2): 61-62. (1975)

Microbial production of single-cell protein was achieved on a laboratory scale, with more than 60% decomposition of untreated pure cellulose.

D3-14 Utilization of brewery spent grains liquor by *Aspergillus niger*. Hang, Y. D., Splittstoesser, D. F., Woodams, E. E. (Cornell Univ., Geneva, N. Y.) Appl. Microbiol. 30(5): 879-880. (1975)

A. niger was found capable of rapidly converting about 97% of the sugar from brewery-spent grain liquor to fungal mass. The yield of dry mycelium, based on the sugar consumed, was approximately 57%. This fungus produced 1.10% titratable acid (calculated as citric acid) and reduced the BOD by 96%. It was concluded that utilization of brewery-spent grain liquor by *A. niger* may have economic value in waste disposal, and in the production of single-cell protein and citric acid.

D3-15 A cellulolytic enzyme from the wood destroying basidiomycete B-531, Part I Growth of the fungus and enzyme production. King, N. J., Smith, G. A. Int. Biodeterior. Bul. 9(4): 87-90. (1973)

The basidiomycete B531 is compared with *Coniophora cerebella*. The effect of various culture conditions, including different N sources, is described in the production of cellulase. The cellulase has a simple electrophoretic pattern.

D3-16 Fermentation waste fertilizers. Mieno, S. Jap. Kokai 75 75852 (C05F), 05 Nov. 1973, 4 pp. Chem. Abs. 83 162980

Liquid organic fertilizers in slurry form are produced from alcohol distillation waste and homogenized by adding Na glycolate cellulose or starch.

D3-17 Use of cellulase preparations for improving the digestibility of wheat bran proteins. Janicki, J., Chrapkowska, K. J., Strzyzewska, M. Pr. Kom. Nauk. Roln. Kom. Nauk. Lesn., Poznan. Tow. Przyj. Nauk. 41: 125-131. (1976) Chem. Abs. 85 141544

The effect of cellulase and cellulase-proteinase digestion on protein extracted from wheat bran was investigated.

D3-18 Utilization of cellulosic materials through enzymic hydrolysis. II. Preliminary assessment of an integrated processing scheme. Wilke, C. R., Cysewski, G. R., Yang, R. D., Von Stockar, U. (Lawrence Berkeley Lab., Univ. Calif., Berkeley) Biotechnol. Bioengin. 18(9): 1315-1323. (1976)

An integrated processing scheme is described for the conversion of newsprint to sugars by enzymic hydrolysis, and then to EtOH and yeast by fermentation. The unconverted solids are burned to produce process energy requirements and surplus electric power.

D3-19 Studies on celluloytic enzyme production by mold and its application. Wang, L. H., Yuan-Chi, S. Mem. Col. Agr. Natl. Taiwan Univ. 9(2): 1-15. (1968) Biol. Abs. 51 010654

A celluloytic enzyme was isolated from *Trichoderma lignorum* that had 12 times the specific activity of a crude enzyme. Application of a cellulolytic enzyme to agricultural waste was studied and good results were obtained.

D3-20 Semi solid fermentation of rye grass straw. Han, Y. W., Anderson, A. W. Appl. Microbiol. 30(6): 930-934. (1975)

The digestibility and protein content of straw is enhanced by treating it with dulute acid, ammoniating the acid-treated straw, and fermenting it with a yeast such as *Candida utilis*. The treated straw is useful as a feed for ruminants and other animals.

D3-21 Activity of fungal cellulase preparations on barley bran for increasing feed value. Janicki, J., Gembicka, D., Chrapkowska, K. J. (Inst. Technol. Zywn. Pochodzenia Roslinnego. Akad. Roln., Poznan, Poland) Pr. Kom. Nauk. Roln. Kom. Nauk. Lesn., Poznan. Tow. Przyj. Nauk. 41: 117-123. (1976)

Treatment of barley bran with fungal cellulase preparations for 60 min at 100° C gave 33-50% decomposition of cellulase, an increase of sugars from 7 to 48% in relation to cellulose, and an 80% increase in available protein.

D3-22 Classification of yeasts that utilize cellulose wastes. Sevoyan, G. G., Sarukhanyan, F. G., Stephanyan, M. L., Akhinyan, R. M., Karimyan, R. S., Petrosyan, L. G. Biol. Zh. Arm. 29(6): 57-61. (1976) Chem. Abs. 85 175545

Of the yeast strains isolated from industrial waste waters, *Candida pelliculosa* 507 and *Torulopsis pulcherrima* 90 produced more biomass suitable as fodder than did *T. uvae*, *T. candida*, *T. albida*, *T. famata*, *C. melinii*, and *C. brumptii*, when grown on hydrolyzates of waste waters from cellulose production.

D3-23 Effect of cellulose-lignin decomposing microorganisms on the the food value of straw. Silvers, V. S., Spravstsev, N. K., Dorozhko, V. P., Gorobets, A. N., Gvozd, G. A. Visn. Silsk. kogospod. Nauk. 9: 54-57. (1976) Chem. Abs. 85 191050

Straw ensiled after addition of fungi decomposing cellulose and lignin and lactic-acid bacteria was utilized better than untreated straw by fistulated beef cattle.

D3-24 Enzymic activity of paper-decomposing fungi. Nyuksha, Y. P., Kossior, L. A. Mikol. Fitopat. 10(3): 185-190. (1976) Chem. Abs. 85 188952

The enzymic activity of paper-decomposing fungi may be used for characterization of paper of different compositions.

D3-25 Enzymic refining of unconventional protein for nutritional purposes. Bednarski, W., Poznanski, S., Jedrychowski, L., Leman, J., Szczepaniak, M. J. Milk Food Technol. 39(8): 521-525. (1976)

Studies were made on the possibilities of refining protein from the fodder yeast, *Candida utilis*, from *Kluyveromyces fragilis* cells and the field bean, with papain and pepsin, followed by the reverse synthesis of proteins from hydrolyzates treated with alpha-chymotrypsin.

D3-26 Cellulose digestibility of fibrous materials pretreated with *Trichoderma viride* cellulase. Autrey, K. M., McCaskey, T. A., Little, J. A. J. Dairy Sci. 57(1): 132-133. (1974)

Studied cellulose digestibility of corn silage, ensiled with 0-20% on a dry matter basis of fungal cellulase, E. C. 3.2.1.4., of *T. viride*, using the nylon-bag technique on six rumen-fistulated cows.

D3-27 Semisolid fermentation of alkali treated straw. Yu, P. L., Han, Y. W., Anderson, A. W. (Dept. Microbiol., Oreg. State Univ., Corvallis) Proc. Ann. Mtg. Amer. Soc. Anim. Sci., West. Sect. 27: 189-191. (1976)

Annual ryegrass straw was treated with 4% NaOH or 5% NH_4OH, and aerobically fermented with a mixed culture of a *Cellulomonas* sp. and *Alcaligenes faecalis* on a semisolid substrate.

D3-28 Changes in microbial population during fermentation of feedlot waste with corn. Hrubant, G. R. Appl. Microbiol. 30(1): 113-119. (1975)

A new process for recycling feedlot waste involves the fermentation of this waste combined with corn. Changes in the flora of the silage-like fermentation were followed. Information on the sequence of micro-organism provides a basis for enhanced SCP production in the fermentation.

D3-29 Biosynthesis of cellulases by thermophilic cellulose fermenting bacteria. Scherbakov, M. A. Izv. Akad. Nauk. Mold SSR Ser. Biol. Khim. Nauk. 1: 45-50. (1974) Biol. Abs. 59, 048829

Selective culture of thermophilic cellulose fermenting bacterium No. 110 on Pervozvanskii mineral medium with 1% corn extract is reported. Enzyme activities are compared, using winter wheat straw or filter paper as additional C source.

D3-30 Effect of cultivation conditions on the formation of cellulolytic and pectolytic enzymes by *Xanthomonas malvacearum*. Sattarova, R. K., Tashpulatov, Zh., Safiyazov, Zh. Mikrobiologiya 41(3): 413-416. (1972) Biol. Abs. 59 036349

Optimum conditions for the formulation of cellulolytic and pectolytic enzymes were determined during submerged cultivation of some strains of *X. malvacearum* on media with various C sources. Mineral Czapek-Dox medium with 10% green cotton leaves was best at 30° C. Optimum pH varied with different strains.

D3-31 Extraction of cellulase from culture filtrate of *Trichoderma viride* by settling with acetone. Chomoneva, T. M., Sofroniev, N. Biol. Abs. 59, 039113

Some parameters of acetone settling with cellulose enzyme from the culture medium were investigated, and the following optimal limits were fixed: 89% saturation with acetone, acetate buffer with ionic strength .01 and pH 4.5, temperature--20° C, and continuance 12 to 16 hr. The phopholipids settled with acetone were removed by centrifugation after solution in water. The recovery of celluloytic enzyme activity is 90%.

D3-32 Enzymatic hydrolysis of waste cellulose. Mandels, M., Hontz, L., Nystrom, J. Biotechnol. Bioengin. 16(11): 1471-1493. (1974)

Waste cellulose was a suitable C source for *T. viride* cellulase production while using newspaper as a growth substrate with submerged cultivation. Cellulose fractions separated from municipal trash or agricultural residue, such as milled fiber from bovine manure, are promising substrates for conversion.

D3-33 Solid state fermentations. Hesseltine, C. W. Biotechnol. Bioengin. 14(4): 517-532. (1972)

A unique method is described whereby large yields of secondary metabolites are produced in solid substrates--rice, corn, wheat, and other cereals. Extremely high yields of ochratoxin and aflatoxin were obtained. The process prevents sporulation and makes recovery of the product easier than recovery in conventional liquid media.

D3-34 *In vitro* and *in vivo* production of cell wall degrading enzymes by *Botrytis cineria* from tomato. Verhoeff, K., Warren, J. M. Neth. J. Plant Path. 78(4): 179-185. (1972) Biol. Abs. 55 004359

Studied the production and activity of pectolytic and cellulolytic enzymes by *B. cinerea* in tomato plants, as well as by the conidia of this fungus in some nutrient media. Cellulase was only found in those parts that were softened by the invading mycelium.

D3-35 Utilization of agricultural waste materials for the production of calcium lactate by fermentation. Tewari, H. K., Vyas, S. R. J. Res. Punjab Agr. Univ. 8(4): 460-462. (1971) Biol. Abs. 55 013836

The production of Ca lactate from molasses by *Lactobacillus delbruckii* was studied by using different growth factors from *P. aureus* (moong) sprouts and *P. aconetifolus* and various oil seed cakes. The addition of 5% moong sprouts was optimum for the maximum conversion of molasses to Ca lactate within 7 days at 50° C.

D3-36 Microbial utilization of cellulosic materials as a commercial venture. McLoughlin, A. J. Irish Forestry 29(1): 15-19. (1972)

A review of several processes for obtaining wood sugar and other important chemicals from hydrolysis of cellulose and hemicellulose. The future of wood hydrolysis seems to be in the modification of existing processes like pulping. States we need more knowledge about structure and decomposition of cellulose, and more large-scale pilot plant studies.

D3-37 Microbiological and chemical study on the conservation of an animal feed in the form of hay and as a silage hay. Clari, L., Pacini, N. Ann. Microbiol. Enzymology 18(5-6): 215-226. (1968) Biol. Abs. 51 056190

This work exposed the experimental data concerning both the microbiological and chemical research on forage obtained either through maximum drying or through incomplete drying by pneumatic compression from the first grass cut from a meadow. Factors like moisture, compression, aerobic, and anaerobic were studied, but treatments did not make a difference from an alimentary standpoint.

D3-38 Comparison of batch and semi continuous cultures for production of protein from mesquite wood by *Brevibacterium* sp. Fu, T. T., Thayer, D. W. Biotechnol. Bioengin. 17(12): 1749-1760. (1975)

Production of protein by a *Brevibacterium* using mesquite wood as the substrate was compared between batch and semicontinuous cultures. The cultures were compared on the basis of viable cell counts, protein production, carboxymethyl cellulase activity, and filter paper cellulase activity. The semicontinuous process yielded 2.97 times as much protein in 72 hr as the batch culture. Most of the biomass resulted from the utilization of soluble sugars rather than from the degradation of cellulose during the semicontinuous process.

D3-39 Fermentation of agricultural wastes by yeast. Nagy, G., Vaillant, M., Balint, K., Sos, A. Biotechnol. Bioengin. 17(12): 1823-1826. (1975)

Reports that the chemical composition and molecular structure of the cell wall varies somewhat in different plants, so the optimum form of pretreatment for SCP production must be determined for each substrate. The effects of such pretreatments are not limited to the solubilization of cellulose; important changes occur in other plant constituents which may determine the conditions and economy of the process. The results obtained in fermentation experiments with acid-pretreated corncob and kenaf stems by *Torulopsis utilis* are reported.

D3-40 Degradation of barley glucan and lichenan by a *Bacillus pumilus* enzyme. Suzuki, H., Kaneko, T. Agr. Biol. Chem. 40(3): 577-586. (1976)

A bacterial strain was isolated from soil that rapidly degraded purified barley beta-glucan and lichenan. The strain belonged to *B. pumilus*; some authentic strains of this species also hydrolyzed the glucan. An enzyme active on the above substrates, but not on laminaran or carboxymethyl cellulose, was partially purified from the culture fluid. States that only an enzyme of this type should be called a lichenase and be discriminated from cellulases and laminaranases.

D3-41 Yield of feed-protein concentrate from waste cellulose. Nagy, G., Balint, K. E., Sos, A. (Mikrobiol. Kut. Csoport. Magy. Tud. Akad., Budapest, Hungary) Elelmez. Ipar 29(2): 41-45. (1975) Chem. Abs. 83 095047

Native cellulose solubility can be enhanced by different chemical, physical, and combined methods. Fermentation by rumen bacteria by sugarbeet, fodderbeet, and bean leaves is a relatively slow process. Starting at 10^6 cells/ml, a threefold increase can be obtained in 3 days at 37° C with 10^6 cell/ml of cellulolytic yeast strains on a corncob substrate and a twofold increase can be obtained at 37° in 16 to 24 hr.

D3-42 Biological degradation of cellulose and practical aspects of its use as a fermentation material. Krcmar, S. (Vysk. Ust. Liehovarov Konzervarni, Bratislava, Czechoslovakia) Kvasny Prum. 21(4): 83-84. (1975) Chem. Abs. 83 191277

A review with four references on the utilization of cellulose as a substrate for bacterial multiplication. Applications to the manufacture of proteins, antibiotics, and insecticides from wood hydrolyzates are discussed.

D3-43 Hydrolytic degradation of bagasse by enzymes produced by *Penicillium variabile*. Garcia Martinez, D. V., Ogawa, T., Shinmyo, A., Enatsu, T. (Dept. Ferment. Technol., Osaka Univ., Suita, Japan) Hakko Kogaku Zasshi 52(6): 378-387. (1974) Chem. Abs. 83 191313

An enzyme preparation capable of hydrolyzing sugarcane bagasse was obtained from the culture filtrate of *Penicillium variabile* in a medium containing wheat bran and alkali-treated bagasse.

D3-44 Cellulase and protein production from mixed cultures of *Trichoderma viride* and a yeast. Peitersen, N. (Dept. Appl. Biochem., Tech. Univ. Denmark, Lyngby/Copenhagen, Denmark) Biotechnol. Bioengin. 17(9): 1291-1299. (1975)

Fermentations with mixed cultures of *T. viride* and yeast *Saccharomyces cerevisiae* or *Candida utilis* were examined. The yeast presence reduced the production time for maximum yields of cellulase by several days. The protein of final product was 21%. The amino acid profile was similar to *T. viride*.

D3-45 Yeast protein-containing feed. Dhnel, J. P., (England) Ger. Offen. 2444301 (A23J) 18 Sept. 1973, 12 pp.

Feed material was obtained by mixing dried *Candida lipolytica* grown on paraffin hydrocarbons, 45-47.5; bruised corn, 45-47.5, and casein with gluten, 5-10%, adding H_2O, extrusion at 127° C and 250 g/min and drying 30 min at 70° to 100° C.

D3-46 Microbial cellulytic enzymes: Production, properties, and applications. Korculanin, A., Juric, Z., Pospisil, O., Matanic, H. Mikrobiologija (Belgrade) 12(1): 81-95. (1975) Biol. Abs. 62 066194

This review is related to the production of cellulases by microorganisms and culture conditions, as well as the mechanisms of action and methods of separation and purification of enzymes. Present and future applications are also reported.

D3-47 Heterogeneity of cellulolytic enzymes of *Asperigillus terreus*. Tashpulatov, Z. Uzp. Biol. Zh. 15(5): 14-16. (1971) Biol. Abs. 55 004581

Cellulolytic enzymes, isolated from culture liquid of *A. terreus*, were heterogeneous. They consisted of cellulase that catalyzed the disintegration of native cellulose to its low-molecular form, and carboxymethylcellulase that disintegrated soluble forms of cellulose to glucose.

D3-48 Fermentation of waste mechanical fibers from a newsprint mill by the rot fungus *Sporotrichum pulverulentum*. Eriksson, K. E., Larsson, K. Biotechnol. Bioengin. 17(3): 327-348. (1975)

Studied the growth and protein production of *S. pulverulentum* in submerged cultures, using lignin-containing waste fibers from a newsprint mill as the only C source. The influence of different N sources on growth parameters was particularly investigated. The protein content in the residual substance decreased as the crystallinity of the cellulose increased. The more complex the C source, the more enzyme had to be produced for its degradation, which put a heavy burden on the protein-synthesizing mechanism. Mentions possibilities of producing a final product with a high-protein content by using complex C sources.

D3-49 Production of cellulase and protein from barley straw by *Trichoderma viride*. Peitersen, N. Biotechnol. Bioengin. 17(3): 361-374. (1975)

The cellulase produced by two strains of *T. viride* was examined. Fungi were grown on barley straw pretreated with NaOH under high pressure. Investigated production of cellulases and protein of the better strain in a five-liter fermentor under stirring rates of 200-350 rpm and straw concentrate ratios of 1-2%.

D3-50 Microbial fermentation of rice straw: Nutritive composition and *in vitro* digestibility of the fermentation products. Han, Y. W. Appl. Microbiol. 29(4): 510-514. (1975)

Rice straw was fermented with *Cellulomonas* sp. and *Alcaligenes faecalis*. Microbial cells and undigested residue, as well as chemically treated NaOH or NH_4OH straw, were analyzed for nutrient composition and *in vitro* digestibility. In a typical fermentation, 75% of the rice straw was digested and 18.6% of the total substrate was recovered as microbial protein.

D3-51 Studies on thermophilic cellulolytic fungi. Romanelli, R. A., Houston, C. W., Barnet, S. M. Appl. Microbiol. 30(2): 276-281. (1975)

The thermophilic cellulolytic fungi *Chaetomium thermophile* var. *coprophile*, *Sporotrichum thermophile*, and *Thermoascus aurantiacus* were studied to determine conditions for high rate of decomposition. Optimum temperatures for substrate utilization were: *T. aurantiacus*, 48° C; *S. thermophile* and *C. thermophile*, 40°. *S. thermophile* gave the highest (56%) substrate utilization.

D3-52 Fibrous material in feedlot waste fermented by *Trichoderma viride*. Kaneshiro, T., Kelson, B. F., Sloneker, J. H. Appl. Microbiol. 30(5): 876-878. (1975)

T. viride fermented fiber isolated for feedlot waste at concentrations up to 16% solids. The fermented fiber solids decreased by 32% and carbohydrate decreased by 60%. Cellulolytic enzyme production was better with fiber substrates that were alkali-pretreated and had a lower hemicellulose-to-cellulose ratio.

D3-53 Microbial utilization of *Pinus radiata* bark. Updegraff, D. M., Grant, W. D. Appl. Microbiol. 30(5): 722-726. (1975)

A screening program using suspensions from ground bark yielded more than 200 cultures; 38 gave good growth on liquid bark media--all filamentous fungi. Cell biomass yields, measured by cell N determination, were too low for economic production of SCP.

D3-54 Protein production from acid whey via fermentation. Bernstein, S., Everson, T. C., Natl. Environment Res. Center Symposium, pp. 151-166. (1973)

Saccharomyces fragilis was chosen from eight yeast strains screened as the organism for large-scale continuous production of single cell protein by fermentation of acid or sweet whey in a deep-tank, aerated, agitated fermentor. The fermentation has no contamination problems, as it operates at low pH (4.5), with large seed size (10-20% of fermentor volume) and high cell count. Economics of production are discussed; using acid whey as raw material, costs are estimated at 9.2-13.4 cents/lb of product.

D3-55 Microalgal protein as food. Florenzano, G. (Cent. di studio dei microorganismi autorofi del cnr. Univ. Degli Studi, Firenze, Italy) Riv. Ital. Delle Sostanze Grasse 52(1): 11-25. (1975) 75 08 G0504 FSTA

The production, utilization and nutritive value of microalgal protein is discussed. Tabulated data show the annual productivity in kg/ha, percent of composition of *Scenedesmus acutus* and *Spirulina plantensis*, percent of total protein N of some green and blue-green algae from mass open-air culture, and the amino-acid composition of proteins of blue-green algae. Compared to other single-cell proteins, the algal biomasses have high protein contents with a balanced amino acid pattern (FAO standard), except for the S-containing amino acids and low nucleic-acid contents.

D3-56 Fermented straw for animal feed. Han, Y. W., Grant, G. A., Anderson, A. W., Yu, P. L. Feedstuffs 48(17): 17, 19-20. (1976)

Two semisolid fermentation methods were developed to ferment grass straw for a ruminant feed. The first method was hydrolysis of the straw by dilute acid followed by yeast fermentation. The second involved alkali treatment followed by growth of celluloytic organisms on the straw.

D3-57 Studies on the production of fermented feeds from agricultural waste products. Part 1. On the productions and characteristics of xylanase by *Aspergillus niger*. Lee, K., Lee, H. (Col. Agr., Seoul Natl. Univ., Seoul, So. Korea) Hanguk Nonghwa Hakhoe Chi 18(3): 109-116. (1975) Chem. Abs. 85 003847

A. niger strains 1701 and 430, which showed the highest production of xylanase, were selected. The production of xylanase from strain 1701 was increased with the addition of 21% carboxymethyl cellulose, 19% $(NH_4)H_2PO_4$) and 20% corn-steep liquor, whereas strain 430 was not affected. The optimum concentrations of xylan as a substrate in the hydrolysis with 33.3% crude enzyme solution was 2% at pH 5.0 and 60° C for 3 hr and hydrolysis was 95% complete.

D3-58 Nutritive value of mixed fermented feed, basically combined rice straw with molasses and distillers' condensed solubles. Kametaka, M. (Faculty Agr., Univ. Tokyo, Tokyo, Japan) Hakko Kyokaishi 33(4-5): 29-43. (1975) Chem. Abs. 83 057197

In distillers' condensed solutions, N compounds were remarkably less well utilized as N source than casein or urea, but the rapidly fermentable substances were utilized well. Oxen given the mixed fermented feed at 11-13 kg/day had near normal growth.

D3-59 Production of highly active cellulase preparationa and optimization of enzymic cellulose hydrolysis. Bruchmann, E. E., Kirsch, B., Lauster, M. (Inst. Allg. Lebensm. Tech. Biochem., Univ. Hohenheim, Germany) Chem.-Ztg. 99(3): 157-158. (1975) Chem. Abs. 83 0414178

Methods for production of highly active cellulase preparations and optimization of enzymic hydrolysis of cellulose are briefly discussed.

D3-60 Microbial reactor design for synthetic protein production. Moo-Young, M. (Dept. Chem. Engin., Univ. Waterloo, Waterloo, Ontario) Canad. J. Chem. Engin. 53(2): 113-118. (1975)

A review with 35 references. Physical factors that may affect the performance of a microbial reactor for producing synthetic protein are discussed in terms of chemical engineering principles. It is shown that an appreciation of these principles can be used to maximize the productivity of synthetic protein from lignin, hydrocarbon, and cellulose fermentations.

D3-61 Utilization of cellulosic wastes by *Trichoderma viride*. Toyama, N., Ogawa, K. (Faculty Agr., Miyazaki Univ., Miyazaki, Japan) Terui, G. (ed.) Fermentation Technol. Today, Soc. Fermentation Technol., Osaka, Japan, pp. 743-757. (1972)

Several studies were performed for producing sugar solution from a variety of cellulosic or woody wastes by the cellulolytic activity of a fungus, *T. viride*.

D3-62 The mechanism of enzymatic cellulose degradation. Pettersson, L. G., Axiö-Fredriksson, U., Berghem, L. E. R. (Inst. Biochem., Univ. Uppsala, Uppsala, Sweden) Terui, G. (ed.) Fermentation Technol. Today, Soc. Fermentation Technol., Osaka, Japan, pp. 727-729. (1972)

Using the C_1-Cx concept, the authors examine the mechanism of cellulose degradation. The C_1, or initial attacking enzyme, is hydrolytic, and acts synergistically with the Cx enzymes, which randomly split β-1,4 glucosidic bonds; the C_1 enzyme consecutively removes cellobiose units from the free end.

D3-63 Potential application for cellulase enzymes. Allen, W. G., Gaden, E. L., Jr. (ed.) Sixth Biotechnol. and Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 303-306. (1976)

Enzymatic technology for cellulose conversion is technically viable, but the economics for private business are not attractive.

D3-64 Study on the enzymatic degradation of cellulose. Amsallem, B. Int. Biodeterior. Bul. 6(4): 135-138. (1970)

Cellulolytic complex fractionation gave only one cellulase fraction active on insoluble cellulose. A β-glucosidase was determined by characterization of C_x enzymes with various soluble substrates.

D3-65 Cellulosic substrates for enzymatic saccharification. Andren, R. K., Erickson, R. J., Medeiros, J. E. Gaden, E. L., Jr. (ed.) Sixth Biotechnol. and Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 177-204. (1976)

This study surveys the current status of investigations into potential cellulosic substrates for enzymatic saccharification. Properties of the most reactive substrates are discussed. The effect of critical process parameters and the economics of the saccharification process are examined.

D3-66 The fermentative degradation of potato starch granules. Czaja, A. T. Staerke 24(5): 162-166. (1972) Biol. Abs. 55 057263

Demonstrates the difference between the fermentation of the starch granules, as a whole, during germination in the living cells of the potato tuber, and the enzymatic destruction of the isolated starch granules by micro-organisms.

D3-67 Application of hemicellulase, naringinase and hesperidinase. Fukomoto, J., Tsujisaka, Y., Okada, S., Yamamoto, T. (Faculty Sci., Osaka Univ. Munic. Tech. Res. Inst., Osaka, Japan) Proc. Symposium on Conversion and Manufacture of Foodstuffs by Micro-organ., Kyoto, Japan, 1971. (1972)

Hemicellulase was used to dehull grains, clarify fruit juice, and improve digestibility of soybeans. Naringinase was used to remove the bitter flavor--naringin--in summer oranges. Hesperidinase was used to clarify mandarin oranges.

D3-68 The problem of rice straw waste a possible feed through fermentation. Han, Y. W., Anderson, A. W. Econ. Bot. 28(3): 338-344. (1974)

This paper discusses processes utilized to produce animal feed from straw.

D3-69 Production of *Pleurotus ostreatus* on waste celluloses. Hashimito, K., Takahashi, Z. (Toyo Jr. Col. Food Technol., Kawanishi, Japan) Kanzume Jiho 55(2): 153-157. (1976) Chem. Abs. 85 019943

In comparison with pine sawdust and rice hulls, chopped rice straw, with the addition of rice bran at 10-15% at 70% moisture, was most satisfactory as a medium for the production of mushrooms *P. ostreatus*.

D3-70 Utilization of citrus by-products. I. Protein enrichment of orange peel fodder by growth of yeast. Hernandez, E., Legorburo, M. B., Lequerica, J. L., Martin, F., Lafuente, B. (Inst. Agroquim. Tecknol. Aliment Valencia, Spain) Rev. Agroquim. Tecknol. Aliment. 15(3): 415-422. (1975) Chem. Abs. 84 988256

The development of a protein-rich feed was studied while growing *Candida utilis* on ground orange peel.

D3-71 Increasing protein content of a waste food product. Hruby, F. J. U.S. Patent 3904768 (426-53; A23K), 4 pp. (1966)

The digestible crude protein in a waste product from the food industry was increased by adding urea or NH_4 compounds, cooking under pressure, cooling, fermenting, and drying.

D3-72 Enzymatic hydrolysis of cellulose to sugar. Huang, A. A. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 245-252. (1975)

Kinetic studies were made on the hydrolysis of amorphous, or mixtures of amorphous, and crystalline cellulose to sugars by cellulase. Mathematical equations were elaborated from the data obtained.

D3-73 Use of by-products of the starch glucose industry for the protein production for feed purposes. Part 2. Study on the possibility of yeast enrichment of maize mash. Ikonomova, A. Zhivotn. Nauki. 9(7): 21-28. (1972) Chem. Abs. 78 82921y

Study done on yeast enrichment of maize using *Candida utilis*, *C. tropicalis*, and *Endomycopsis fibuligera*.

D3-74 Use of yeasts in the silage preparation of feeds containing a bacterial fermentation starter. Il'ina, K. A., Skolov, P. I. Tr. Inst. Mikrobiol. Virusol. 20: 110-115. (1974) Chem. Abs. 83 146004

Leaven yeast, without lactic acid, was used in silage fermentation.

D3-75 Energy and protein from cellulose. Linko, M. (Biotek. Lab., Valtion Tekh. Tutkimuskeskus, Helsinki, Finland) Kem.-Kemi 2(12): 602-605 (1975) Chem. Abs. 84 149259

Discusses the production of yeast protein or EtOH energy from cellulose by way of hydrolysis to glucose; and the technology for production of cellulases.

D3-76 Microbial sources of cellulase. Mandels, M. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 81-105. (1975)

This paper discusses the criteria for selection of a micro-organism as a cellulase source, and the methods for measurement of cellulase activity. Cellulases from active strains are compared, and the effect of carbon source on cellulase activity is determined. Many successful attempts were made to produce cellulase in continuous fermentation in glucose. The authors have not yet found a constitutive mutant that will produce high levels of cellulase on glucose medium.

D3-77 Measurement of saccharifying cellulase. Mandels, M., Andreotti, R., Roche, C. Gaden, E. L., Jr. (ed.) Sixth Biotechnol. and Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 21-34. (1976)

The filter paper assay and unit value described here is not perfect--measurement of cellulase is complex, but it is simple, reproducible, quantitative, and predicts enzyme action under practical saccharification conditions.

D3-78 Improving the digestibility of animal feeds. Matsuoka, S. Brit. Pat. 1,317,803, May 16, 1973. Chem. Abs. 79 64854v

Animal feed with improved digestibility was prepared from material containing indigestible cellulose and lignin, for instance bagasse or leaves and stalks of grasses. Thus, a medium was inoculated with *Aspergillus niger*, nitro bacteria, *Penicillium*, and wood-rotting bacteria to give, after cultivation and fermentation at 30° to 45° C, a composite inoculum containing ligninase and cellulase. A substrate of bagasse and raw spirit lees was added and the mixture cultured and fermented at less than 40, pH 4-6 to decompose the lignin and cellulose. Lignin content was reduced from 22.02 to 12.48% and the digestibility was increased for the crude cellulose from 31.4 to 73.6%.

D3-79 Physical and chemical pretreatments for enhancing cellulose saccharification. Millett, M. A., Baker, A. J., Satter, L. D. Gaden, E. L., Jr. (ed.) Sixth Biotechnol. and Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 125-154. (1976)

States pretreatments have to alleviate two major constraints: Lignin and cellulose crystallinity. Electron irradiation and vibratory ball milling reduce cellulose crystallinity. Partial delignification is promising.

D3-80 The rate and products of degradation of xylans by rumen hemicellulases. Morrison, I. M. Biochem. Soc. Trans. 3(6): 992-994. (1975) Chem. Abs. 84 051085

Hemicelluloses were hydrolyzed 10-40% by rumen hemicellulase preparations with the extent of hydrolysis varying with the time of day (that is, time after feeding) and the nature of the feed.

D3-81 Biological effects of sulfite waste liquor components for swine. Naess, B. (Vet. Col.., Oslo, Norway) Tannenbaum, S. R. and Wang, D. I C. (ed.) Single Cell Protein II, MIT Press, Cambridge, Mass., pp. 545-552. (1975)

About 0.6% of lignosulfonic acids remains in SCP produced from sulfite waste liquor. Pigs were given diets containing 0, 3, 6, 13% lignosulfonic acids. Toxic level was between 6-13%. The toxic mechanism is thought to be inhibition of enzymes, especially proteinases.

D3-82 Fermentation of agricultural wastes by yeast. Nagy, G., Vaillant, M., Balint, K., Sos, A. Biotechnol. Bioengin. 17(12): 1823-1927. (1975)

The results obtained in fermentation experiments with acid-pretreated corncobs and kenaf stems by *Torulopsis utilis* 82 were satisfactory.

D3-83 Cellulase digestion in sheep fed an extract of *Aspergillus-oryzae*. Niver, J. W., Tucker, R. E., Mitchell, G. E., Jr. J. Anim. Sci. 32(2): 389. (1971)

Sheep were fed an extract of *A. oryzae* to measure the effect on cellulose digestion, but the extract did not appear to affect cellulose digestion.

D3-84 Pilot scale investigations and economics of cellulase production. Nystrom, J. M., Allen, A. C. Gaden, E. L. (ed.) Sixth Biotechnol. Bio-engin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 55-74. (1976)

The production of a high-quality, cell-free enzyme, on a prepilot plant scale, has been successful. A process for industrial scale production of cellulase has been proposed and an economic evaluation has been performed.

D3-85 Changes in biochemical constituents of some organic waste materials under anaerobic methane fermentation. Prasad, C. R., Gulati, K. C., Idnani, M. A. (Indian Agr. Res. Inst., New Delhi, India) Indian J. Agr. Sci. 40(10): 921-994. (1970) Chem. Abs. 74 130140

Studied changes in the composition percent of holocellulose, cellulose, hemicellulose, lignin, pentosans, and methoyl contents of organic materials after fermentation of various sytems--such as cow dung, cow dung-gum arabic, cow dung-wheat straw, cow dung-peanut shells, and cow dung-sugarcane bagasse-- by methane organisms.

D3-86 Production of methane gas from organic wastes under anaerobic conditions. I. Important factors influencing formation of combustible gases. Rizk, S. G., Farag, F. A., El-Mofty, M. Kh., El-Fadl, M. (Min. Agr., United Arab Republic) Agr. Res. Rev. 46(2): 53-66. (1968) Chem. Abs. 71 53297

As a first step in producing CH_4 on a commercial scale, laboratory experiments were carried out to ferment (under restricted O conditions) rice straw, corn stalks, cotton stalks, and buffalo dung. Factors affecting gas yield, such as $CaCO_3$ and $(NH_4)_2SO_4$, variation in incubation temperature, ratio between materials and aqueous solution in fermentors, and changes in pH, were studied.

D3-87 Solid substrate fermentation of feedlot waste combined with feed grains. Rhodes, R. A., Orton, W. L. Trans. Amer. Soc. Agr. Engin. 18(4): 782-733. (1975)

Cracked corn mixed with the N-rich liquid obtained by passing cattle feedlot waste through an oscillating 30-mesh screen in a ratio of 1:2 was aerobically fermented in a slowly revolving vessel for 36 hr, resulting in amino acid and total N increases of 18 and 12%, respectively, over the unfermented corn product.

D3-88 Enzymatic degradation of cellulosic fibers. Rinaudo, M., Barnoud, F., Merle, J. P. Marschessault, R. H. (ed.) Polymer Sci., Part C. Polymer Symposia, Sixth Cellulose Conf. Proc., John Wiley and Sons, New York, pp. 197-207. (1969)

Compared the enzymic attack by an active cellulose preparation upon native cotton, swollen cotton, and regenerated cellulose.

D3-89 Dry feed yeast from hydrocarbon fermentates. Rosa, M., Vernerova, J. Czech. Patent 157752 (C12B), 2 pp. (1965) Chem. Abs. 84 015705

Yeast milk from the fermentation of liquid hydrocarbons was spray-dried at 165° C (output temperature 85° C) and the powdered product was treated with a solvent to remove residual oil. The treatment is cheaper than azetropic dehydration of crude yeast paste and has a high deodorizing effect.

D3-90 Enzymic hydrolysis of cellulose-containing plant materials. Schauer, H., Annemueller, W., Heidrick, S., Huber, J. Ger. Offen. 1,950,729 (Cl. C12 d) 18 Jun. 1970, Germany (East) Appl. 24 Oct. 1968, 10 pp.

Plant materials such as straw or dried spent malt were enzymatically hydrolyzed after pretreatment of the comminuted material, with 0.2-3% H_2SO_4 or 0.5-5% NaOH with or without heating and pressure.

D3-91 Specific enzymatic degradation of polysaccharides in delignified wood cell walls. Sinner, M., Parameswaran, N., Yamazaki, N., Liese, W., Dietrichs, H. H. Twenty-Eighth Appl. Polymer Symposium: 993-1024. (1976)

From commercial enzyme preparations of *Aspergillus* sp., *Trichoderma viride*, and *Oxyporus* sp., one endo-β-1,4 mannanase, six endo-β-1,4 xylanases, one carboxymethyl cellulase, two avicelases, and one β-glucosidase were isolated, and their characteristics determined. It appears, from the chemical analysis of degradation products and from electron microscopy of the degraded material, that in holocellulose, xylan can be selectively hydrolyzed by the action of endo-β-1,4-xylanase; mannan cannot be decomposed by endo-β-mannanase; and cellulose can be attacked only after the xylan has been at least partly removed. This supports the idea of xylan as a material deposited between, or encrusting the cellulose fibrils.

D3-92 Production of cellulase by *Trichoderma*. Sternberg, D. Gaden, E. L. (ed.) Sixth Biotechnol. Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 35-54. (1976)

Optimum conditions for producing cellulase from *Trichoderma viride* are being investigated.

D3-93 Treatment of soybean spent solubles by means of yeast cultivation. Sugimoto, H. J. Food Sci. 39(5): 934-938. (1974)

The yeast cultivation on soybean-spent solubles derived during preparation of soybean protein, by a combination of isolectric precipitation and heat coagulation, was investigated in order to eliminate BOD, COD, and to produce SCP simultaneously. It seemed to be practical.

D3-94 Feasibility of sugar production from agricultural and urban cellulosic wastes with *Trichoderma viride* cellulase. Toyama, N. Gaden, E. L. (ed.) Sixth Biotechnol. Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 207-220. (1976)

Almost complete saccharification of delignified rice straw and bagasse, and the production of a thick sugar solution from these substrates have been achieved by using a 1% solution of an active *T. viride* commercial preparation, Cellulase onuzuka CLA 762, after incubation at 10 and 20% substrate concentrations, pH 5.0, 45° C for 48 hr.

D3-95 Microbiology of waste treatment. Unz, R. F. J. Water Pollut. Control Fed. 48(6): 1367-1378. (1976)

A review covering micro-organisms of sanitary significance: Biopolymers, microbial byproducts from waste treatment, nuisance microorganisms, waste-water microbial characteristics, and factors affecting microbial activities. Gives 71 references.

D3-96 Fundamental aspects of the uses of starch degrading enzymes. Whelan, W. J. (Dept. Biochem., Univ. Miami, Fla.) Proc. Internatl. Symposium on Conversion and Manufacture of Foodstuffs by Micro-org., Kyoto, Japan, 1971. Saikon Publishing Co., Ltd., pp. 87-94. (1972)

Discusses the application and mechanism of enzymes that degrade starch and pullulan to smaller units.

D3-97 Preliminary cost analyses for enzymatic hydrolysis of newsprint. Wilke, C. R., Yang, R. D., Von Stockar, U. Gaden, E. L. (ed.) Sixth Biotechnol. Bioengin. Symposium. Enzymatic Conversion of Cellulosic Materials, John Wiley and Sons, New York, pp. 155-176. (1976)

A preliminary cost analysis for the enzymatic hydrolysis of newsprint is given, taking into account the process description, base cost estimation, justification and effects of design variables, and cost assumptions.

D3-98 Another source of cellulase. Wood, T. M., Phillips, D. R. Nature (London) 222(5197): 986-987. (1969)

The cell-free filtrate from *Fusarium solani* grown on native Texas cotton fiber contained amounts of cellulase comparable to those produced by *Trichoderma koningi*. *F. javanicum* also produced extracellular cellulase in slightly less quantity.

D3-99 Properties and mode of action of cellulases. Wood, T. M. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 111-137. (1975)

Cellulase, a multicomponent enzyme system, has been resolved into its component parts by using various chromatographic and electrophoretic techniques. There are at least three different types of enzymes in the complex.

D3-100 Production of sugars from waste cellulose by enzymatic hydrolysis. I. Primary evaluation of substrates. Andren, R. K., Mandels, M. H., Medeiros, J. E. Appl. Polymer Symposium 28: 205-219. (1975)

This paper reports on the availability and susceptibility of more than 30 representative cellulosic wastes to enzymatic saccharification.

D3-101 Fermentation of ensiled broiler litter for livestock feed. Caswell, L. F., Fontenot, J. P., Webb, K. E., Jr. Res. Div. Rpt., Va. Polytech. Inst. and State Univ. Res. Div. 158: 100-109. (1974)

Broiler litter will sustain fermentation, when ensiled, if moisture is at least 30%. Pathogens are destroyed through ensiling.

D3-102 Carbon dioxide inhibition of yeast growth in biomass production. Chen, S. L., Gutmanis, F. (Univ. Foods Corp., Milwaukee, Wis.) Biotechnol. Bioengin. 18(10): 455-462. (1976)

Saccharomyces cerevisiae, grown under substrate limiting conditions, was inhibited by CO_2 only when aerated with air containing 40% or more CO_2.

D3-103 Conversion of cellulosic waste by *Sporotrichum pulverulentum* into protein as fodder. Ek, M., Eriksson, K. E. Appl. Polymer Symposium 28: 197-203. (1975)

Describes laboratory-scale research on the conversion of cellulosics into fodder by the white rot fungus *Sporotrichum pulverulentum*.

D3-104 Fermented ammoniated condensed whey as a protein source. Henderson, H. E., Reddy, C. A., Crickenberger, R. J. Anim. Sci. 39(1): 240. (1974)

Fermented ammoniated condensed whey is 50% crude protein and is prepared by adding ammonia to whey during fermentation and later condensing it to 60% solids. It was an adequate N source for steers.

D3-105 Adaptation of the koji fermentation to waste disposal. Kassai, P. T., Chase, T., Jr., Eveleigh, D. E., MacMillan, J. D. Abs. Ann. Mtg. Amer. Soc. Microbiol. 73: 3. (1973)

Waste paper and poultry manure were used as substrates to solubilize waste in a Koji-type process. Koji is enzyme-producing stage; moromi is degradation phase.

D3-106 Evaluation of forage with cellulolytic enzymes from *Trichoderma viride*. McQueen, R. E., Van Soest, P. J. J. Dairy Sci. 56(5): 680. (1973)

T. viride enzymes were used to evaluate digestibility of forage fed to ruminants.

D3-107 Poultry manure to protein feed via fermentation. Miller, B. F. Poultry Sci. 54(5): 1795. (1975)

Various energy supplements and organisms were used to ferment poultry manure. Feed resulting was 90% of N as protein.

D3-108 High-temperature production of protein-enriched feed from cassava by fungi. Reade, A. E., Gregory, K. F. Appl. Microbiol. 30(6): 897-904. (1975)

Aspergillus fumigatus, a thermophilic, amylase-producing mold, was used to produce SCP from cassava.

D3-109 *Rhodoturula mucilaginosa* growth response to an oxidized annual rye grass lignin. Rockhill, R. C., Anderson, A. W. Abs. Ann. Mtg. Amer. Soc. Microbiol. 72: 14. (1972)

Klason lignin was prepared from ryegrass straw and oxidized with varying concentrations of H_2O_2 at pH 3 and 100° C. The oxidation fragments were used as a substrate for *R. mucilaginosa*.

D3-110 Problems and potential associated with the production of protein from cellulosic wastes to produce food and energy products through fermentation. Rogers, C. J. J. Wash. Acad. Sci. 66(1): 271-277. (1976)

Describes technical constraints hindering development of viable bioconversion of the cellulose in agricultural and municipal wastes, and ways of converting cellulose to SCP are described.

D3-111 Enzymatic hydrolysis of cellulosic wastes to glucose for the production of food, fuel, and chemicals. *Trichoderma viride*, fungal fermentative agent. Spano, L. A., Medeiros, J., Mandels, M. J. Wash. Acad. Sci. 66(1): 279-294. (1976)

This paper discusses the production and mode of action of the cellulase complex produced during the growth of *T. viride* and the application of such enzymes for the conversion of various municipal, agricultural, and industrial cellulosic wastes.

D3-112 Enzymatic saccharification of cellulose by thermophilic Actinomyces. Su, T. M., Paulavicius, I. Appl. Polymer Symposium 28: 221-236. (1975)

Two strains of thermophilic Actinomyces that produce extracellular enzymes were isolated to degrade cellulosic fiber.

D3-113 Waste cellulose bioconversion by filamentous marine fungi in submerged culture. White, J. L., Sguros, P. L., Rodrigues, J. Abs. Ann. Mtg. Amer. Soc. Microbiol. 72: 15. (1972)

In a simulated marine environment, *Calcitalna achraspora*, *Halospheria mediosetiger*, and *Zalerion xylestrix* converted cotton to protein in 2 weeks.

D3-114 Sensitive assay for cellulase and dextranase cellulose. Huang, J. S., Rang, J. Anal. Biochem. 73(2): 369-377. (1976)

Synthesis of two chemically modified carboxymethyl cellulose substrates provide a sensitive, rapid, and quantitative assay for cellulase and dextranase.

D3-115 Fermentative and enzymatic aspects of cellulose degradation. Srinivasan, V. R., Fleenor, M. B. Murray, E. (ed.) Devlpmt. Indus. Microbiol. Vol. 13 AIBS, Wash. D.C., pp. 47-53. (1972)

Culture of two organisms, a *Cellulomonas* species with cellulolytic activity, and *Alcaligenes faecalis* with cellobiase activity, on sugarcane bagasse to degrade cellulose and produce microbial protein.

D3-116 Enzymatic degradation of polysaccharides of the pulp of coffee beans. Wosiaki, G., Zancan, G. T. Arq. Biol. Technol. 16(2): 129-134. (1973) Chem. Abs. 81 148622

The microbial flora of coffeebeans collected in the vicinity of Sao Paulo consisted predominantly of *Penicillium*, *Cladosporium*, *Fusarium*, and *Aspergillus* species. The enzymes liberated from the fungi isolated from culture media were able to break down pectic acid and galactoarbinan--components of the mucilaginous coating of the beans.

D3-117 Production of methane from straw. Mikkelson, J. P., Skotte, H., Nissen, T. V. (Bakteriol. Afd., Statens Planteavls-Lab., Lyngby, Denmark) Tidsskr. Planteavl. 78(5): 652-656. (1974) Chem. Abs. 83 007096

Preliminary laboratory-scale experiments were carried out to produce CH_4 from straw by inoculating the material with digested sludge. The anaerobic decomposition of dry matter of 1 g of straw yielded 190 ml gas--50% CH_4, 40% CO_2.

D3-118 The use of waste heat in a system for animal waste conversion with by-product recovery and recycling. Boersma, L., Barlow, E. W. R., Miner, J. R., Phinney, H. K., Oldfield, J. E. (Oreg. State Univ., Corvallis) Synthetic Foods, NTIS, U.S. Dept. Com., 12 pp. (1976)

A system was designed to use micro-organisms to convert swine waste into high-protein animal feed and a methane-rich fuel gas. Algae are grown on swine manure, which is a suitable medium for nutrient recovery based on its mineral composition.

D3-119 Photosynthetic reclamation of agricultural solid and liquid wastes. Golueke, C. G., Oswald, W. J., Dugan, G. J., Rixford, C. E., Scher, S. (Sanitary Engin. Res. Lab., Univ. Calif., Berkeley) Synthetic Foods, NTIS, U.S. Dept. Com., 32 pp. (1976)

An integrated anaerobic fermentation and algae growth system for agricultural solid and liquid wastes was studied on a laboratory and pilot plant scale, with special attention given to the reaction kinetics of the system.

4. Cellulose Decomposition

D4-1 Straw decomposition by fungi (*Basidiomycetes*), with its subsequent use as a feed supplement or compost. Zadrizil, F. (Inst. Bodenbiol., Forsch. Anst. Landw., Braunschweig., Germany) Landw. Forsch. Sonderh. 32(2): 153-167. (1976) Chem. Abs. 85 191056

Edible species of *Basidiomycetes* and *Ascomycetes* were tested for growth on wheat straw.

D4-2 Moisture absorption mold growth and decomposition of rice straw at different relative humidities. Sain, P., Broadbent, F. E. Agron. J. 67(6): 759-762. (1975)

Ground rice straw was exposed to constant relative humidities to measure moisture absorption, decomposition, and mold growth.

D4-3 Microbial decomposition of tree and shrub leaf litter. 1. Weight loss and chemical composition of decomposing litter. Howard, P. J., Howard, D. M. (Inst. Terr. Ecol., Natl. Environ. Res. Council, Cumbria, England) Oikos 25(3): 341-352. (1974)

Leaves of various tree and shrub species, treated with X-rays to kill animals, were allowed to decompose (usually for 2 years) under field conditions in open-ended glass tubes containing soil.

D4-4 Microbial degradation of condensed tannins. Grant, W. D. (Cawthron Inst., Nelson, N. Z.) Science 193(4258): 1137-1139. (1976)

A strain of *Penicillium adametzi* Zaleski was isolated from enrichment cultures with condensed tannins as the C source. Low-molecular-weight tannins extracted and purified from *Pinus radiata* bark were used as substrates for quantitative growth measurements on the fungus in defined culture conditions.

D4-5 Kinetics of solka floc cellulose hydrolysis by *Trichoderma viride* cellulase. Howell, J. A., Stuck, J. D. Biotechnol. Bioengin. 17(6): 873-894. (1975)

A product inhibition model was developed to describe the hydrolysis of cellulose by the *T. viride* enzyme system.

D4-6 Mechanism of enzymic cellulose degradation. Pettersson, L. G., Axio-Frederiksson, U. B., Berghem, L. E. (Inst. Biochem., Univ. Uppsala, Uppsala, Sweden) Ferment. Technol. Today, Fourth Internatl. Ferment. Symposium Proc., pp. 727-729. (1972)

In studying the mechanism of enzymic cellulose degradation, enzymic material obtained from a commercial preparation, Cellulase Onozuka SS derived from *Trichoderma viride*, was used on the substrates carboxy-methyl-cellulose, a highly crystalline hydrocellulose, and cellobiose.

D4-7 The utilization of various forms of nitrogen fertilizers for the decomposition of cellulose. Pokorna-Kozova, J. Ved. Pr. Vyzkumn., Ust. Rostl. Vyroby. Praze-Ruzyni 13: 19-24. (1968)

The utilization of NH_3-N was quicker and showed greater intensity of cellulose decomposition than that of nitrate N. Natural soil conditions were better for NH_3-N utilization and cellulose decomposition. If N-free substances with a high cellulose content are introduced into the soil, the application of fertilizers containing NH_3-N is more profitable.

D4-8 Effect of pH on cellulose digestion under *in vitro* conditions. Terry, R. A., Tilley, J. M. A., Outen, G. E. J. Sci. Food Agr. 20(5): 317-320. (1969)

The extent of cellulose digestion by rumen micro-organisms *in vitro* is dependent on the pH of the medium. Digestion is greatly reduced at pH values similar to those found within the rumen of sheep fed diets rich in readily digested carbohydrates.

D4-9 Aerobic decomposition of straw in a microbial batch cultivator. Posadskaya, M. N., Trubachev, I. N., Veber, M. E. Izv. Sib Otd. Akad. Nauk. SSR Ser. Biol. Nauk. 1: 62-66. (1976) Biol. Abs. 007861

Studied the possibility of microbial decomposition of air-dried wheat straw by specific biocenosis of activated sludge (actinomycetes, yeasts and mold fungi) in a batch microbial cultivator. The decomposition of organic straw components lasted less than 4 days. Lignin decomposition of the straw was as high as 32.3% and degradation of cellulose was 76% in 4 days.

D4-10 Fundamental study of the mechanism and kinetics of cellulose hydrolysis by acids and enzymes. Tsao, G. T. Purdue Univ., LaFayette, Ind. Energy Res. Devlpmt. Admin. Rpt. No. 18, E(11-1)-2755, 41 pp. (1976)

This project deals with acidic and enzymatic hydrolysis of cellulosic materials for the first 8 months of the project.

D4-11 Can wood-rot fungi degrade cellulose without other wood constituents? Highley, T. L. (For. Prod. Lab., Agr. Res. Serv., Madison, Wis.) For. Prod. J. 25(7): 38-39. (1975) Chem. Abs. 83 144284

A study was conducted to determine if white-rot fungus (*Coriolus versicolor*) and a brown-rot fungus (*Poria monticola*) could degrade cellulose if wood was not present. *C. versicolor* readily degraded, but *P. monticola* did not degrade cellulose in absence of wood. Wood may have an inducer for brown-rot fungi.

D4-12 Enzymic hydrolysis of wheat straw by cellulases from the thermotolerant *Aspergillus terreus* 17P. Guzhova, E. P., Burdenko, L. G., Loginova, L. G. (Inst. Microbiol., Moscow, U.S.S.R.) Prikl. Biokhim. Mikrobiol. 12(4): 587-590. (1976) Chem. Abs. 85 092153

A preparation of cellulolytic enzymes that was isolated from the submerged culture of *A. terreus* 17P hydrolyzed wheat straw cellulose. With an increase of exposure and concentration of the enzyme, the percentage of straw hydrolysis and sugar yield increased. Maximum was 12-day exposure to 25% enzyme at 50° C, -24.8% hydrolysis, and 17% sugar yield.

D4-13 The degradation of cellulose and the production of cellulase, xylanase, mannase, mannanase, and amylase by wood attacking micro fungi. Nilsson, T. Stud. For. Suec. 114: 1-61 (1974) Biol. Abs. 58 066160

Species of 36 wood-inhabiting microfungi were assayed for cellulose, xylanase, mannanase, and amylase activity. Twelve species could not degrade pure cellulose; they formed soft-rot cavities in solid birch. These 12 were called non-cellulolytic-soft-rot fungi.

D4-14 Kinetic studies on insoluble cellulose cellulase system. Huang, A. A. Biotechnol. Bioengin. 17(10): 1421-1433. (1975)

Describes investigation of enzymatic hydrolysis of insoluble amorphous cellulose by *Trichoderma viride* cellulase in a batch reactor at several substrate concentrations and three enzyme levels.

D4-15 Hemi cellulases of white rot and brown rot fungi in relation to host preferences. Highley, T. L. Mater. Org. (Berlin) 11(1): 33-46. (1976) Biol. Abs. 62 068981

The hemicellulose-degrading enzymes of a brown-rot and a white-rot fungus were compared for differences that could be responsible for fungal host preferences.

D4-16 The influence of yeast extract on the degradation of cellulose by mold fungi. Waelchli, O. Mater. Org. (Berlin) 11(1): 19-31. (1976) Biol. Abs. 62 069182

The influence of yeast extract by various mold fungi in nutritive solution on the degradation of cotton cellulose was investigated.

D4-17 Mechanism of enzymic hydrolysis of cellulose by *Trichoderma viride*. Pettersson, L. G. (Inst. Biochem., Univ. Uppsala, Sweden) Symposium Enzym. Hydrolysis Cell., pp. 255-261. (1975)

Four different cellulolytic enzymes from *T. viride* have been purified to the stage of physico-chemical homogeneity. One of the enzymes, which has been characterized as an exo-β-1, 4-glucanase, catalyzes the hydrolysis of microcrystalline cellulose up to 80% and up to 40% solubilization. A mechanism is given that explains the cooperation of the different enzymes in the degradation of cellulose.

D4-18 Kinetics of solka floc cellulose hydrolysis by *Trichoderma viride* cellulase. Howell, J. A., Stuck, J. D. (Dept. Chem. Engin., State Univ. N.Y., Buffalo) Biotechnol. Bioengin. 17(6): 873-893. (1975)

A simplified product inhibition model was developed to describe the hydrolysis of cellulose by the enzyme system from *T. viride*.

D4-19 Cellulose decomposition by a Phythiaceous fungus. Park, D. (Bot. Dept., Queen's Univ., Belfast, Northern Ireland) Trans. Brit. Mycol. Soc. 66, pt. 1, pp. 65-70. (1976)

Phythium C 1, a river isolate, decomposed filter paper disks in a salts solution after an initial weight gain in the paper, possibly due to contaminating soluble C compounds present.

D4-20 Enzymic mechanisms of cellulose degradation caused by the rot fungus *Sporotrichum pulverulentum*. Eriksson, K. E., Pettersson, B., Westermark, U. (Sw. Forest Prod. Res. Lab., Stockholm, Sweden) Biol. Transform. Wood Micro-org., Proc. Sess., pp. 143-152. (1975) Chem. Abs. 85 001567

A review with seven references on the enzymes of *S. pulverulentum* involved in cellulose degradation.

D4-21 Influence of temperature on the kinetics of rice straw decomposition in soils. Pal, D., Broadbent, F. E., Mikkelsen, D. S. Soil Sci. 120(6): 442-449. (1975)

Using tracer techniques, investigated the influence of 7.2, 22, and 37° C temperature levels on the extent and rates of rice straw decomposition and loss of soil organic matter in two soils at 60% water-holding capacity.

D4-22 Sensitized photo degradation of cellulose and cellulosic wastes. Eskins, K., Bucher, B. L., Sloneker, J. H. Photochem. Photobiol. 18(3): 195-200. (1973)

The photodegradation of cellulose and cellulose-containing waste by a variety of dyes was measured by means of viscosity, tensile strength, and scanning electron microscopy.

D4-23 Studies on wood degradation and cellulolytic activity of micro fungi. Nilsson, T. Stud. For. Suec. 104: 1-40. (1973) Biol. Abs. 58 007405

The cellulolytic activity and wood-degrading ability of 160 different species of microfungi, mostly wood-inhabiting, were investigated. The cellulolytic activity was determined by a clearing method. The wood-degrading ability was determined microscopically on sections of decayed wood blocks. The enzymatic attack on three hardwoods and two softwoods was examined. Most studies were performed with birch wood, which was used as a "standard wood" for comparisons. Two morphologically distinct types of attack were observed: Type 1--cavity formation, and Type 2--erosion of cell walls.

D4-24 Hemi cellulase activity of some species of molds. Tashpulatov, Z. H. Uzbek. Biol. Zh. 17(4): 22-23. (1973) Biol. Abs. 58 004759

A study of the hemicellulase and xylanase activity of some species of *Aspergillus* (*A. terreus*-1 and *A. fumigatus*), *Trichoderma* *T. koningii* and *T. roseum*), and *Stemphylium botrysoum*-11 and *Chaetomium globosum*) established that *Trichoderma* sp. and *Trichoderma lignorum*-263 have the highest hemicellulase and xylanase activity.

D4-25 Degradation of cellulosic materials by *Trichoderma viride* cellulase. Gupta, J. K., Gupta, Y. P., Das, N. B. Agr. Biol. Chem. 37(11): 2657-2662. (1973)

The extracellular filtrates of *T. viride* ITCC-1433 showed considerable cellulolytic activity against native celluloses, cellulose derivatives, and raw materials. Yellow newspaper and rice straw were prominent waste materials that were preferentially attacked by the enzyme, but alkali treatment of the latter doubled its sugar yield.

D4-26 Cellulose digestibility of fibrous materials treated with *Trichoderma viride* cellulase EC-3.2.1.4. Autrey, K. M., McCaskey, T. A., Little, J. A. J. Dairy Sci. 58(1): 67-71. (1975)

Studied cellulose digestibility of corn silage ensiled with 0, 0.05, 0.10, and 0.20% of fungal cellulase, EC 3.2.14 of *T. viride* using the nylon bag technique on six rumen-fistulated cows.

D4-27 Degradation of corn cell walls by extracellular enzymes produced by *Helminthosporium maydis* race T. Bateman, D. F., Jones, T. M., Yoder, O. C. Phytopathology 63(12): 1523-1529. (1973)

Endopolygalacturonase and endoxylanase were produced by *H. maydis* race T. growing on a mineral salts-glucose medium at 23° C. Pectin lyase (endopectin methyltrans-eliminase) with a pH optimum of about 8.5 was produced by the fungus on potato broth-Na polypectate or mineral salts-glucose-Na polypectate media.

D4-28 Observations on the degradation of cellulose fibers by the fungus *Papularia arundinis*. Ionita, I. Rev. Roumain. Biol. Ser. Bot. 18(2): 125-127. (1973) Biol. Abs. 57 001990

Presents some microscopic observations on the degradation of cardboard cellulose fibers by *P. arundinis*. The ability of the fungus to penetrate the cellulose fibers and to develop--both at the surfaces of fibers and within them--is demonstrated and discussed.

D4-29 Breakdown of cellulose by yeast species. Dennis, C. J. Gen. Microbiol. 71(2): 409-411. (1972)

Nine out of 12 strains of *Trichosporon curaneum* and 12 out of 13 strains of *T. pullulans* degraded cellulose into glucose and cellobiose. Yeasts of other genera lacked this ability. Production of cellulase may be of use in yeast identification and classification.

D4-30 The potential digestibility of cellulose in grasses and its relationship with chemical and anatomical parameters. Wilkins, R. J. J. Agr. Sci. 78(3): 457-464. (1972)

Potential cellulose digestibility, measured by incubation *in vitro* for 6 days, decreased during floral development in perennial ryegrass, cocksfoot, oat, and tall fescue. Lignin content was determined chemically by the method of Van Soest (1963) and lignified tissues were assessed by staining transverse sections of leaf blades and leaf sheaths with safranin and fast green. Limitations to the techniques used to assess lignification and further factors that may affect the relationship between lignification and potential cellulose digestibility are discussed.

D4-31 Cellulose biodeterioration and biodegradation. Bevers, J., Verachtert, H. Agricultura (Louvain) 22(3): 165-248. (1974) Biol. Abs. 59 066264

Discusses the importance to man of a balance between cellulose formation and breakdown, the influence of cellulose structure on biological breakdown, and cellulose-biodegrading organisms.

D4-32 The mechanism of enzymatic cellulose degradation. Purification and some properties of two different 1,4-beta-glucan glucanohydrolases from *Trichoderma viride* fungi. Berghem, L. E. R., Petterson, L. G., Axio-Fredriksson, U. B. European J. Biochem. 61(2): 621-630. (1976)

A low-molecular-weight and a high-molecular-weight 1,4-beta-glucan glucanohydrolase (C_X enzyme) were isolated from a commercial cellulase preparation derived from culture filtrates of the fungus *T. viride*.

D4-33 Physical and chemical constraints in the hydrolysis of cellulose and lignocellulosic materials. Cowling, E. B. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 163-182. (1974)

The physical and chemical features of cellulose and lignocellulosic materials that determine their susceptibility to both chemical and biochemical conversion processes are reviewed.

D4-34 Summary discussion on the products of cellulose hydrolysis. Finn, R. K. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 279-283. (1975)

Gives a brief overview of the products of cellulose utilization, such as fuel, fodder, and chemicals.

D4-35 The acid hydrolysis of refuse. Grethlein, H. E. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 303-318. (1975)

The utility of the acid hydrolysis of refuse as a fermentation and a growth medium was studied. Ethanol and torula yeast were produced successfully.

D4-36 Inhibition of cellulases of wood decay fungi. Highley, T. L. U.S. Forest Serv. Res. Paper FPL 247, pp. 1-8. (1975)

Twenty-five compounds were tested for cellulase inhibition in white- and brown-rot fungi.

D4-37 Hydrogen peroxide and iron: A microbial cellulolytic system. Koenigs, J. W. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 151-159. (1976)

Presents circumstantial physiological evidence that suggests brown-rot fungi employ an H_2O_2 + Fe system in nature. Three general features of this system that might be exploited to treat cellulose are described.

D4-38 Studies on lignin hemicellulose complexes. Krinstad, K. P., Cheng, C. W. Tappi J. 52(12): 2382-2385. (1969) Biol. Abs. 51 063145

Discusses possible explanations for the observation that on gel filtration of water-soluble lignin-hemicellulose complexes isolated from spruce chlorite holocellulose, the molecular size distribution curve for polysaccharides is always accompanied by a lignin distribution curve of similar shape.

D4-39 Process development studies on the enzymatic hydrolysis of cellulose. Wilke, C. R., Mitra, G. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 253-274. (1975)

This paper reports the results and cost estimates of several conceptual design studies on the enzymatic hydrolysis by *Trichoderma viride* of cellulose as it occurs in newsprint. The author suggests that most of the applications of petroleum and coal could be replaced by a cellulose-based chemical and energy industry.

D4-40 Hemicellulose degradation by rumen bacteria. Dehority, B. A. Fed. Proc. 32(7): 1819-1825. (1973)

Rate and extent of hemicellulose degradation of forages was studied, with particular emphasis on the other bacterial interactions involved in hemicellulose, cellulose, and pectin digestion.

D4-41 Cellulose degradation by *Ruminococcus albus*. Leatherwood, J. M. Fed. Proc. 32(7): 1814-1818. (1973)

Presents characteristics of cellulose digestion by *R. albus* with special emphasis on their relationship to the recently proposed mechanism of cellulose degradation.

D4-42 Enzymatic mechanisms of cellulose degradation caused by the rot fungus *Sporotrichum pulverulentum* (*Chrysosporium lignorum*). Eriksson, K. E., Pettersson, B., Westermark, U. Biol. Transform. of Wood by Micro-org. Proc. of the Sess. on Wood Prod. Path, Second Internatl. Cong. Plant Path., pp. 143-152. (1975)

Gives methods of enzyme study and an analysis of the cellulose degradation by *S. pulverulentum*.

D4-43 Degradation of cellulosic wastes by *Diplodia gossypina*. Lynch, G. P., Smith, D. F., Simpson, M. E., Marsh, P. B. J. Dairy Sci. 58(8): 1241-1242. (1975)

The fungus *D. gossypina*, a pathogen of cotton, was grown on cellulosic wastes to determine its effect on product degradation.

D4-44 Forage soluble nitrogen effects on ammonia production and cellulose digestion. Prigge, E. C., Apgar, W. P. J. Anim. Sci. 37(1): 354. (1973)

In vitro cellulose digestion and NH_3 production were determined on five forages--alfalfa, red clover, three orchard grasses, timothy and reed canarygrass--that were incubated for varying time periods.

D4-45 Acidic cellulose degradation products from wood attacked by *Sporotrichum pulverulentum*. Westermark, U., Eriksson, K. E. Sven Papperstidn 78(18): 653-656. (1975) Chem. Abs. 84 86688

The white-rot fungus *S. pulverulentum* was grown in submerged cultures with spruce fibers or cellulose powder as the sole C sources.

D4-46 Structure and enzymic hydrolysis of the cellulose of grasses. Dudkin, M. S., Shkantova, N. G., Lemle, N. A. Tezisy Dok. - Vses., First Konf. Khim. Fiz. Tsellyul. 1: 106-109. (1975) Chem. Abs. 85 158159

The cellulose of cereals was more susceptible to enzymic hydrolysis than the cellulose of legumes. Lignin and hemicellulose interfered with the enzymic hydrolysis.

D4-47 Oxidative enzymes of cellulose-decomposign fungi. Astanov, T., Nailekova, N. N. Obraz. Fiziol. Akt. Veshch. Mikro-org., pp. 122-138. (1975) Chem. Abs. 85 188935

Fungi play a part in the formation of soil humus while degrading plant remains.

D4-48 Enzymatic hydrolysis of waste cellulose. Mandels, M., Hontz, L., Nystrom, J. (U.S. Army Natick Lab., Natick, Mass.) Biotechnol. Bioengin. 16(11): 1471-1493. (1974)

Strains of *Trichoderma viride* and *Pestaloptiopsis westerdijkii* were cultured on media containing cellulose, and the activity of the cellulase produced was examined under a variety of conditions using various waste products rich in cellulose. *T. viride* was the more useful, in that waste cellulose itself proved to be a suitable carbon source for cellulase production. The extent of saccharification ranged from 2-92% and depended upon cellulose crystallinity, particle size, presence of impurities, and the type of pretreatment used for the cellulose. Ball milling of the cellulose waste gave good particle size reduction. Fluid energy milling, colloid milling, or alkaline treatments proved less satisfactory. Municipal trash and fibers from bovine manure provided good substrates for conversion of waste cellulose into crude glucose syrups.

D4-49 Biodegradation of cellulosic substrates. Meyers, S. P. (La. State Univ., Baton Rouge) Off. Naval Res., Arlington, Va., Rpt. No. 18, 15 pp. (1976)

Mechanisms for accelerated biodegradation of cellulosic substrates have been examined, especially analyses and optimization of pretreatment of the fiber prior to microbial digestion. Methodology has been developed for enumeration of cellulolytic micro-organisms and quantitative evaluation of cellulose transformation in the environment. Overall data suggest that selected physical/biodegradative techniques can be developed to accelerate rates of cellulose decomposition in the aqueous environment.

D4-50 Decomposition of the straw-cellulose-lignin complex by *Pleurotus florida* and its use. Zadrazil, F. (Forschungsstelle Sengbusch, Hamburg, Germany) Z. Pflanzenernaehr. Bodenk. 3: 263-278. (1975) Chem. Abs. 83 190182

Under controlled conditions, straw decomposition resulted in the degradation of holocellulose, α-cellulose, and lignin in wheat straw by *P. florida*. It was found that spent *Pleurotus* can be used as fertilizer or ballast feed.

5. Lignin Decomposition

D5-1 Pyrolysis gas chromatography of lignin. Kitao, K., Watanabe, Y. (Wood Res. Inst., Kyoto Univ., Japan) Zaiyo 16(169): 844-847. (1967) Chem. Abs. 68 88328a

Milled wood lignin prepared from pine, beech, and rice straw was pyrolyzed at 500° C in He and analyzed at 124° C or 160°-180° C by pyrolysis gas chromatography. Silicone oil DC 550 (30%) on celite 545, 5% diethylene glycol succinate on Chromosorb W, and 5% Apiezon N on Chromosorb W were used for column packings.

D5-2 Degradation of lignin by combined chemical and biological treatment. Stern, A. M., Gasner, L. L. Biotechnol. Bioengin. 16(6): 789-805. (1974)

Ozonolysis of lignin caused its partial depolymerization to decolorized biodegradable products which could be used by *Candida utilis*, *Aspergillus niger*, *Rhizopus stolonifer*, and *Penicillium chrysogenum* as their sole source of C.

D5-3 Biological degradation of lignin. Trojanowski, J. Int. Biodeterior Bul. 6(3): 119-124. (1969)

A review with 37 references; no further information.

D5-4 Radiactivity assay for the microbial decomposition of lignin. Bleam, R. D., Connors, W. J., Kirk, T. K., Zeikus, J. G. Abs. Ann. Mtg. Amer. Soc. Microbiol. 74: 167. (1974)

Synthetic lignin was produced. An assay for the microbiological decomposition of synthetic lignin was developed, based on production of labeled C^{14} degradation products.

D5-5 The influence of brown rot fungi on lignin. Chang, H-M., Brown, W., Cowling, E. B. Phytopathology 59(8): 1021. (1969)

Lenzites trabea can modify lignin and can digest wood polysaccharides.

D5-6 Nutritive evaluation of ammonium lignin sulfonate. Croyle, R. C., Long, T. A. J. Anim. Sci. 33(1): 313. (1971)

Ammonium lignin sulfonate was evaluated as a feed *in vitro* and *in vivo* with lambs.

D5-7 Microbiological degradation of lignin wood destroying fungi. Grushinkov, O. P., Antropova, O. M. Russ. Chem. Rev. 44(5): 431-447. (1975)

Analyzes the most recent studies in the field of microbiological degradation of lignin. Particular attention is devoted to a critical examination of hypotheses about the possible degradation pathways.

D5-8 Bacterial degradation of lignin. 1. Degradation of MWL (milled wood lignin) by *Pseudomonas ovalis*. Kawakami, H. (Faculty Agr., Nagoya Univ., Nagoya, Japan) Mokuzai Gakkaishi 22(4): 252-257. (1976) Chem. Abs. 85 090054

When *P. ovalis* was cultured in a medium containing milled wood lignin (MWL) for 60 days, MWL was decomposed considerably; pine MWL was more readily decomposed than beech MWL by this bacterium.

D5-9 Lignin degrading enzyme system. Kirk, T. K. Wilke, C. R. (ed.) Fifth Biotechnol. Bioengin. Symposium. Cellulose as a Chemical and Energy Resource, John Wiley and Sons, New York, pp. 139-150. (1974)

The lignin polymer is oxidatively attacked in the aromatic nuclei and in the side chains simultaneously, which increases the heterogeneity of an already heterogeneous molecule. This requires a complex system to regenerate the latter. The process is extracellular.

D5-10 Topochemistry of the white-rot, *Coriolus versicolor*, fungal degradation of lignin in birch, *Betula alleghaniensis*, wood as related to the distribution of guaiacyl and syringyl lignins. Kirk, T. K., Chang, H. M., Lorenz, L. F. Wood Sci. Technol. 9(2): 81-86. (1975)

The yields of 1-hydroxy-3-(4-hydroxy-3-methoxphenyl)-2-propanone and 1-hydroxy-3-(3,5-dimethoxy-4-hydroxyphenyl)-2-propanone as a percentage of residual lignin decreased progressively with increasing fungal decay of birch wood by *C. versicolor* as determined in the acidolysis products of decayed samples.

D5-11 Preliminary studies of the decomposition of lignin by bacteria isolated from lignin. Jaschof, H. Geochim. Cosmochim. Acta 28(10): 1623. (1964) Chem. Abs. 62 1838c

Decomposition of wheat straw lignin by several species of the genera *Xanthomonas* and *Micrococcus* was studied under aerobic conditions in a buffered neutral mineral solution containing 0.2% lignin and 0.075 peptone. Ratio of decomposition was less than 4% after 100 days in pure cultures. Mixed *Micrococcus* decomposed 7% of the lignin; upper limit of decomposition was 10%.

D5-12 Brown rot of wood as a model for studies of ligno cellulose humification. Rypacek, V., Rypackova, M. Biol. Plant (Prague) 17(6): 452-457. (1975) Biol. Abs. 62 040447

Humus substance synthesis was investigated in the course of birch wood decomposition by a brown-rot fungus *Piptoporus betulinus*.

D5-13 Microbiological degradation of phenol in the effluent from a wood treatment plant. Vela, G. R., Rainey, J. G. Tex. J. Sci. 27(1): 197-206. (1976)

Presents a report of a basic study on the nature of various parameters and how they affect the bacterial degradation of pollutants present in the effluent water from the treatment yard of a wood-preserving plant in northern Texas.

D5-14 Ultrastructure of rigid and lignified forage tissue degradation by filamentous rumen microorganism. Akin, D. E. J. Bacteriol. 125(3): 1156-1162. (1976)

A small (<1μm), filamentous, branching micro-organism, which was observed in Gram-stained smears of (steer) rumen microflora, degraded tissues in forage samples incubated *in vitro* with rumen fluid. This was observed by scanning and transmission electron microscopy.

D5-16 Microbial degradation of lignocellulose: The lignin component. Crawford, D. L., Crawford, R. L. (Dept. Biol., George Mason Univ., Fairfax, Va.) Appl. Environ. Microbiol. 31(5): 714-717. (1976)

A new procedure was developed for the study of lignin biodegradation by pure or mixed cultures of micro-organisms. Natural lignocelluloses were prepared containing ^{14}C in primarily their lignin components by feeding plants L-phenylalanin -U-^{14}C through their cut stems.

D5-17 Growth of different fungi on delignified wheat straw. Sood, S. M., Raheja, R. K., Mann, G. S. Indian J. Microbiol. 14(4): 181-182. (1974)

Delignified wheat straw, obtained by treating with different concentrations of NaOH, was used to assess the effect of delignification on the growth of different fungi.

D5-18 Oxidative degradation of lignin in an alkaline medium. Nauch.-Issled. Isled. Inst. Gidroliza Rastit. Mater., Leningrad, U.S.S.R., Khim. Ispol z. Lignina, pp. 342-348. (1974) Chem. Abs. 82 141821

Blowing air through a suspension of lignin (residue from the hydrolysis of wood to sugars) in diluted ammonia solution gives organic acids (formic acid, acetic acid, oxalic acid), ammonia lignin, and other products. The optimum process conditions give about 16% acids. The oxidate, after its enrichment with sugars by passage through lignin from the hydrolysis of wood, is heated to remove toxicants and is fermented by *Candida tropicalis* to feed yeast.

D5-19 Food additives, lignin sulfonates. Anon. (Food Drug Admin., Wash., D.C.) Fed. Register (40(35): 7404. (1975)

Lignin sulfonate derived from sisal (*Agave sisalana*) may be used as an ingredient in animal feed under the Federal Food, Drug, and Cosmetic Act.

D5-20 Effects of a brown-rot fungus, *Lenzites trabea*, on lignin in spruce wood. Kirk, T. K. (Forest Prod. Lab., Forest Serv., Madison, Wis.) Holzforschung 29(3): 99-107. (1975) Chem. Abs. 83 093778

Lignin isolated from thoroughly brown-rotted wood was compared to a milled-wood lignin and to an "extractive" lignin from sound wood by elemental and methoxy analysis by UV, IR, and PMR spectroscopic characteristics, and by oxidative and hydrolytic degration studies.

D5-21 Determination of lignin content from IR spectra in preparations of wood of spruce destroyed by the brown rot fungus. Karklins, V. (Inst. Khim. Drev., Riga, U.S.S.R.) Issled., Obl. Khim. Drev., Tezisy Dok., First Konf. Molodykh Uch., pp. 15-16, 00000 1974. (1975) Chem. Abs. 85 016581

Describes a new IR spectrometric method that is based on measurements at 1595-1515 and 2920 cm^{-1} with external standards. A good correlation was observed between values at 1595 and 1515 cm^{-1} and the concentration of lignin was determined by chemical methods.

D5-22 Utilization and polymerization of lignosulfonates by wood rotting fungi. Selin, J-F, Sundman, V., Raiha, M. Arch. Microbiol. 103(1): 63-70. (1975)

The susceptibility of lignosulfonates to the action of lignin-degrading wood-rotting fungi was studied by submitting commercial lignosulfonate (Per itan Na) and fractions of calcium lignosulfonate of different molecular weights to the action of selected white-rot fungi.

D5-23 Bacterial degradation of lignin model compounds. IV. The aromatic ring cleavage of vanillic acid. Kawakami, H. (Faculty Agr., Nogoya Univ., Nagoya, Japan) Mokuzai Gakkaishi 22(4): 246-251. (1976) Chem. Abs. 85 106491

Vanillic-acid ring cleavage was studied as representative of the final aromatic ring cleavage step in lignin decomposition by Pseudomonads. The transformation of vanillic acid to protocatechuic acid was investigated by employing sequential induction.

D5-24 Oxidative enzymes of the lignin-degrading fungus *Pleurotus ostreatus*. Ulezlo, I. V., Uporova, T. M., Feniksova, R. V. (A. N. Bakh Inst. Biochem., Moscow, U.S.S.R.) Prikl. Biokhim. Mikrobiol. 11(4): 535-538. (1975) Chem. Abs. 83 159715

The electrophoretic separation in polyacrylamide gel of laccase and peroxidase isoenzymes of the lignin-degrading fungus *P. ostreatus* was investigated.

D5-25 Chemistry of lignin degradation by wood-destroying fungi. Kirk, T. K. In Biological Transform. of Wood by Micro-org. Proc. of the Sess. on Wood Prod. Pathol., Second Internatl. Cong. Plant Pathol., pp. 153-154. (1975)

The biodegradation of lignin by white-rot and brown-rot fungi are contrasted.

D5-26 Lignin as an indicator in animal nutrition. Barsaul, C. S. Indian Vet. J. 49(1): 68-76. (1972)

In a series of seven digestion trials with oat hay as a basal ration for different species and categories of farm animals, lignin of the oat hay was practically indigestible in cows, buffaloes, sheep, horses, Haryana calves, and buffalo calves. The digestibility coefficients of the organic nutrients obtained by both methods in these cases are comparable, indicating that lignin may be used as an indicator in all the above species, particularly in fodders where lignin is practically indigestible.

D5-27 Photo oxidative degradation of lignin sulfonate to substrates enhancing microbial growth. Rockhill, R. C., Park, J. E., Klein, D. A. J. Environ. Qual. 1(3): 315-317.

Photolysis was evaluated as a procedure by which a recalcitrant polymer could be modified to improve biological availability. Lignosulfonate was used as a model substrate, and *Aspergillus* growth responses were measured by fungal dry weight in relation to substrate C before and after growth. Ligninsulfonate solutions with initial pH values of 3, 7, and 12 were irradiated, and maximum growth response occurred where decoloration was achieved.

D5-28 Influence of carbohydrates on lignin degradation by the white-rot fungus *Sporotrichum pulverulentum*, production of biological pulp. Ander, P., Eriksson, K. E. Sven Papperstidn 78(18): 643-652. (1975) Chem. Abs. 84 86687

S. pulverulentum and a cellulase-less mutant strain (cel 44) were cultivated on agar plates containing kraft lignin and different carbohydrates, birch, pine, and spruce splintwood.

D5-29 Various chemical treatments to remove lignin from coarse roughages and increase their digestibility. Chandra, S., Jackson, M. G. (Col. Agr., U. P. Agr. Univ., Pantnagar, India) J. Agr. Sci. 77(Pt. 1): 11-17. (1971)

Several delignifying agents used in various papermaking processes were compared for their ability to remove lignin and increase the digestibility of several roughages.

D5-30 Decomposition of lignin in rotting straw. Flaig, W. (Inst. Biochem. Bodens, Forschungsanst. Landw., Brunswick-Voelkenrode, Germany) Mushroom Sci. 7: 127-138. (1968) Chem. Abs. 72 99659

Rye straw was mixed with a nutrient solution which in one case contained no Ni salts and in other cases 0.5 and 1.0% of nitrogenous substances in the form of NH_4NO_3 (percentages refer to dry weight of straw). After inoculation with a soil suspension, a series of tests were made in an air-conditioned chamber for 240 days at 29-30° C with a relative humidity of 85-95%. Samples taken at certain intervals were fractionated into groups according to their nature, for example, ether and hot-water extracts, lignin fractions, holocellulose, and α-cellulose.

D5-31 Structure of lignin from annual plants. Lebed, S. B., Demidenko, P. M., Nikolaeva, T. I. Guminovye Udobr. Teoriya I. Praktika Ikh. Primeneniya 4: 172-175. (1973) Chem. Abs. 83 055684

Title only translated.

D5-32 Photosensitive groups in lignin and lignin model compounds. Lin, S. Y., Kringstad, K. P. Tappi J. 53(4): 658-663. (1970)

Comparisons of "photochemical" Δε-curves of some lignin model compounds and spruce milled-wood lignin were made as a means of studying reactions involved in the yellowing by light of "lignin-rich," high-yield pulps.

6 Feed and Feeding Value

D6-1 Utilization of agricultural wastes by *Aspergillus awamori* for the production of glucoamylase. Attia, R. M., Ali, S. A. Rev. Microbiol. 5(4): 81-84. (1974) Biol. Abs. 61 036873

The main industrial use of glucoamylase is in the production of crystalline D-glucose. *A. awamori* was used. The specificity of the carbohydrate structure for glucoamylase production was determined. The results seemed to indicate that glucoamylase production is adaptive.

D6-2 Fertilizer and feed from mandarin orange juice waste. Tanaka, T. Japan. Kokai 75148170 (C05F, A23K), 12 pp. (1974)

Organic fertilizers and animal feeds are produced from waste materials from mandarin orange juice production.

D6-3 The use of coarsely chopped barley straw in high concentrate diets for beef cattle. Forbes, T. J., Irwin, J. H. D., Raven, A. M. J. Agr. Sci. 73(3): 347-354. (1969)

Discusses significantly linear decreases (0.95 kg/week) in live weight gain for each 10% increase in straw intake, significant increases in conversion ratios of dry matter and organic matter with increasing straw intake, and 1.67 units dry matter conversion from each 10% increase in straw intake. Milling straw showed a slight decline in digestibility of most constituents.

D6-4 Addition of straw as a method to decrease the losses of nutrients during feed preservation. Fedulina, N. N., Sechkio, V. S., Sulima, L. A. (VSES. Nauch.-Issled. Inst. S-KH. Mikrobiol., Liningrad, U.S.S.R.) Dokl. Vses. Akad. S-KH. Nauk. (Dvasaw) 8: 15-17. (1976) Chem. Abs. 85 158158

Ensiling of high-moisture clover and alfalfa resulted in a loss of 4.7 and 44%, respectively in dry weight. Losses also occurred in reducing sugars and protein. Adding straw to fresh plant mass at 30% reduced dry weight losses to 0.9 and 5.4%, respectively. Sun drying the plant material to 44 and 54% moisture, respectively, also greatly reduced losses during ensiling.

D6-5 Effectiveness of chemical preparations for preserving sugar beets and their use as hog fodder. Tronchuk, I. S. (Poltavsk, Nauch.-Issled. Inst. Svinovodstva, Poltava) Svinovodstvo 4: 71-77. (1967) Chem. Abs. 67 89890u

The best results in preserving sugarbeets for use as hog fodder were obtained with an ensilage mixture of 80-90% sugarbeets and 10-15% straw of leguminous plants with addition of a mixture of technical HCl 1000 cc, Glauber salt 140 g, and water 4500 cc (5% of silage weight.) Addition of 8-10% solution Na_2CO_3 (8kg Na_2CO_3 per ton of silage) 0.5-1 hr before feeding increased hog consumption of silage by 30-50% and average daily weight by 10%.

D6-6 Studies on the utilization of rice straw as a feed for domestic animals. IV. Effect of structural carbohydrates on the digestibility of rice straw. Kim, K. S., Abe, A., Horii, S., Kameoka, K. (Res. Bur., Ord., Suwon, So. Korea) Hanguk Ch'uksan Hakhoe Chi 18(3): 246-250. (1976) Chem. Abs. 85 158365

Found high crystalline rates of hexosans from acid hydrolyzed straw. Found crystalline rate, cellulose content and structural carbohydrates did not affect digestibility.

D6-7 Studies on the utilization of rice straw as a feed for domestic animals. III. Effect of the quantity and quality of the concentrate on the digestibility of rice straw. Kim, K. S., Itoh, M., Kameoka, K. (Res. Bur., Suwon, So. Korea) Hanguk, Ch'uksan Hakhoe Chi 18(3): 237-245. (1976) Chem. Abs. 85 158444

Japanese native goats were fed 100 g concentrates per day that contained 6.4-17.0% digestible crude protein to test affect on intake and digestibility of rice straw.

D6-8 Growth promoting effects of fermented soybeans for broilers. Chah, C. C., Carlson, C.W., Semeniuk, G., Palmer, I. S., Hesseltine, C. W. Poult. Sci. 54(2): 600-609. (1975)

Factorial experiments are reported on the use of control and fermented soybeans in glucose-soybean diets for broiler chicks with varying protein levels.

D6-9 New supplements for feed protein. Galyamin, L. (Odess. S-Kh. Inst., Odessa, U.S.S.R.) Intensif. S-Kh. Proizvod, pp. 145-147. (1974) Chem. Abs. 85 175932

Preparation OTI-2, containing 6-6.5% N was used to substitute 20% of the protein in the feed of oxen, and OTI-3, containing 7.5% N and 2.9% P, was used in addition to protein and P.

D6-10 Substitute for animal-protein feeds. Dmitrochenko, A. P., Pogorelova, I. E., Zaitseva, N. I. (U.S.S.R.) Zap. Leningrad S-Kh. Inst. 247: 47-53. (1974)

Compositions of a number of protein substitute feeds are given. Mixed feeds No. 56-6 and Special, containing various amounts of hydrolyzed yeast waste, feed yeast, sunflower meal, vitamin B_{12}, and minerals in place of fish and meat-bone meal.

D6-11 Use of ammonized straw pellets as the sole basic diet in ruminant feeding. 1. Feeding trials in dairy cows with ammonized straw pellets as the sole basic diet. Marienburg, J., Bergner, H. (Sekt. Tierprod. Veterinaermed., Humboldt Univ., Berlin, East Germany) Arch. Tierernaehr. 25(5): 393-403. (1975) Chem. Abs. 83 205120

Feeding trials with two groups of dairy cows receiving ammonized straw pellets with varying levels of concentrate as the sole basic diet. In group I, 52% straw gave 120.3 kg feed consumed per 100 kg milk. In group II, 1517.3 kg milk were obtained from 892.5 kg straw plus 682.5 kg pellets. Pellets contained 50% ammonized, dried sugarbeet chips but no extracted meals.

D6-12 Biological conversion of animal wastes to nutrients. Miller, B. F. (Dept. Avian Sci., Col. State Univ., Fort Collins, Col.) Synthetic Foods, NTIS, U.S. Dept. of Com., p. 34. (1976)

Larvae of house flies (*Musca domestica*) were used to process poultry manure, with the pupae being used as a feed supplement. Feeding trials indicated that the protein quality was similar to meat and bone meal or fish meal.

D6-13 The use of processed straw in rations for ruminants. Swan, H., Clarke, V. J. Proc. Eighth Nutr. Conf. Feed Mfr.: 205-233. (1974)

Discusses relationship between voluntary feed intake, metabolize energy and weight gain in relation to levels of barley straw in ruminant diets. Addition of 3-5% weight-by-weight NaOH greatly improves digestibility of straw.

D6-14 Digestibility of grain sorghum stover and wheat straw supplemented with nonprotein nitrogen. Swingle, R. S., Waymack, L. B. J. Anim. Sci. 41 (1): 420-421. (1975)

Twelve growing steers were used to determine the digestibility of straw and stover fed to them with a molasses-urea supplement.

D6-15 The nutritive value of defatted high protein sunflower meal. Delic, I., Stojanovic, S., Stojsaljevic, T., Ilijc, S., Rac, M. (Jugoslovenski Inst. Za Preh Rambenu Ind., Novi Sad, Yugoslavia) Hrana I Ishrana I Ishrana 16 (9/10): 417-422. (1975) 76 11 G0846 FSTA

Briefly discusses studies on the nutritional value of defatted sunflower meal. Rat-feeding trials showed it to be of higher nutritional value than soybean meal.

D6-16 Banana meal as food and as animal feed. Maletto, S., Mussa, P. P., Luna, F. S. Annali Della Facolta Di Medicina Veterinaria Di Torino 20: 67-85. (1973) 75 12 J1805 FSTA

Discusses possible use of banana meal in foods and in animal feeds. Includes tables of data for the composition and digestibility of various types of whole banana meal, banana pulp meal, and banana peel meal.

D6-17 Forage potential of soybean straw. Gupta, B. S., Johnson, D. E., Hinds, F. C., Minor, H. C. Agron. J. 65(4): 538-541. (1973)

Nutritive value was estimated on greenhouse and field-grown plants and plant parts at various stages of maturity by standard techniques of forage chemical analysis, IVRD, and intake and digestibility by ewes.

D6-18 Nutritive value of acid hydrolyzed wood residue in ruminant rations. Butterbaugh, J. W., Johnson, R. R. J. Anim. Sci. 38(2): 394-403. (1974)

Low-acid (La HWR) (0.8% H_2SO_4) and high-acid (Ha HWR) (2.3% H_2SO_4) hydrolyzed wood residues (HWR) were produced by treating 8% hardwood plus 20% pine under pressure and neutralizing with anhydrous ammonia. Lambs could be fed up to 5% La HWR with no change in weight gain. Supplementation of 75% La HWR with soybean meal increased weight gain. Ha HWR was limited to 35% because of palatability but weight gain decreased at 20 and 35% Ha HWR.

D6-19 Experiments with the use of dried orange and lemon pulp in feeding milking cattle. Polidori, F., Lanza, A. Alimant. Anim. 11(11): 551-560. (1967) Biol. Abs. 51 027150

Dried lemon or orange pulp at 20, 30, or 40% substituted for corn and barley did not bring significant variation in milk production or percent milkfat in concentrate mixture at high-protein level. At low-protein level, lemon pulp improved milk production.

D6-20 Food value of green feeds during plant growth. Nagornyi, V. T. (Tselinogr. S-Kh. Inst., Tselinograd, U.S.S.R.) Vest. S-Kh. Nauk. (Moscow) 9: 63-68. (1976) Chem. Abs. 83 175949

Content of wheat, sunflower, and alfalfa at various stages was studied to determine their nutritional value.

D6-21 Influence of molasses lignin-hemicellulose fractions in rat nutrition. Fahey, G. C., Williams, J. E., McLaren, G. A. (Div. Anim. Vet. Sci., West Va. Univ., Morgantown, W. Va.) J. Nutr. 106(10): 1447-1451. (1976)

This study was conducted to determine the chemical nature and growth-stimulating action of the black phenol-carbohydrate complex from fractionation of the nonsugar, nondialyzable components of cane molasses.

D6-22 Effect of feeding chopped and ground wheat straw on the utilization of nutrients and volatile fatty-acids production in growing cow calves and buffalo calves. Shaturvedi, M. L., Singh, U. B., Ranjhan, S. K. Indian J. Anim. Sci. 43(5): 382-388. (1973)

Studied the effect that feeding ground wheat straw had on the digestibility of nutrients and the production and concentration of VFA in the rumen of cow calves and buffalo calves. Grinding reduced the digestibility of crude fiber, but did not effect other components. Cattle and buffalo responded the same.

D6-23 Potential feeding value of whole pineapple plant. Wayman, O., Kellems, R. O., Carpenter, J. R., Nguyen, A. H. (Col. Trop. Agr., Univ. Hawaii, Honolulu, Hawaii) Proc., Ann. Mtg. Amer. Soc. Anim. Sci., West. Sect. 27: 304-306. (1976)

Amounts of H_2O, crude proteins, crude fat, ash, acid-detergent fiber, neutral-detergent fiber, lignin, cellulose, starch, glucose, gross and estimated digestible energy, and green leaves and dried leaves of spent pineapple plant fractions. Ca, P, and crude protein were low in composite samples, and the mineral elements of roots were quite high; but, properly balanced, pineapple plants can be used as a source of energy for beef production.

D6-24 Feeding value and net energy for gain of spent sulfite liquor for beef cattle. Chang, F. S., Riquelme, E., Nissen, S., Dyer, I. A. J. Anim. Sci. 41(2): 625-628. (1975)

Eighteen Hereford steers individually housed and fed were utilized to study the effects of incorporating 8 and 12% spent-sulfite liquor into finishing rations. Weight gain and feed efficiency was the same for control and experimental groups.

D6-25 Comparative nutritional value and the effect of feeding of oat hay and wheat straw on growth, wool yield and utilization of nutrients in Nali lambs. Bhargava, B., Ranjhan, S. K. (Indian Vet. Res. Inst., Izantnager, India) Indian J. Anim. Sci. 46(3): 139-143. (1976)

Twelve Nali lambs were fed oat hay or wheat straw in addition to a concentrate diet for 6 months.

D6-26 The use of rice bran in broiler feeding. Sanz, M. (Inst. Cien. Anim., San Jose De Las Lajas, Cuba) Cuban J. Agr. Sci. 9(3): 305-309. (1975) Chem. Abs. 85 092690

Rice bran substituted for maize at 25, 50, 75, and 100% produced gains and conversions comparable to the control diet, although at highest levels tarsus and skin lost their coloration. An additional natural carotene source is needed.

D6-27 A comparison of supplementary sources of nitrogen and energy for increasing the voluntary intake and utilization of barley straw by sheep. Barry, T. N., Johnstone, P. D. J. Agr. Sci. 86(1): 163-169. (1976)

Chopped barley straw was fed freely to penned Romney wethers. Supplements of urea, ground wheat grain and urea, lucerne hay, and autumn-saved pasture were given for five periods of 3 weeks using a 5x5 Latin-square design.

D6-28 Effects of feeding "Pekilo" single cell protein in various concentrations to growing pigs. Farstad, L., Liven, E., Flatlandsmo, K., Naess B. Dept. Microbiol. Immunol., Vet. Col., Norway, Oslo, Norway) Acta. Agr. Scand. 25(4): 291-300. (1975) Chem. Abs. 84 088411

Possible side effects of various concentrations of Pekilo protein substituting soybean meal in a manioka-based diet were studied on growing pigs.

D6-29 Recycling animal waste as a feed review. Bhattacharya, A. N., Taylor, J. C. (Dept. Anim. Sci., Amer. Univ. Beirut, Beirut, Lebanon) J. Anim. Sci. 41(5): 143-157. (1975)

A review with 153 references on the nutritional value to livestock and poultry of animal wastes, possible agents in wastes that are potential animal and human health hazards, and processing methods for increasing the safety of handling animal wastes.

D6-30 Poultry wastes as a feedstuff for sheep. Flipot, P., McNiven, M., Summers, J. D. Canad. J. Anim. Sci. 55(3): 291-296. (1975)

Six wethers averaging 37 kg were used in a double 3x3 Latin-square design to evaluate poultry wastes as a feedstuff; small silos were used to measure the ensiling characteristics of these diets.

D6-31 Low quality feedstuffs: Alternatives to grain for beef rations. Guyer, P. Q. J. Anim. Sci. 42(3): 778-782. (1976)

Treated crop residues appear to be a logical alternate source of energy feed for supporting a sizable volume of quality beef when grain cannot be used economically.

D6-32 Utilization of pyrethrum waste product as a livestock feed. Were, H. R. (Minist. Agr., Nairobi, Kenya) Proc. Conf. Anim. Feeds Trop. Subtrop. Origin. (1975) Chem. Abs. 84 088463

Gives an account of work carried out in Kenya on the utilization of pyrethrum marc--the waste remaining after the extraction of insecticides from pyrethrum flowers.

D6-33 Straw and grain feeding of sheep. Joyce, J. P. N.Z.J. Expt. Agr. 3(1): 49-54. (1975)

Eight groups of nine 18-month-old wethers were fed one of the following rations over a 56-day period after undergoing a preliminary 42-day hay-feeding period: Barley grain; barley straw; barley straw and urea; barley straw and barley grain; barley straw, barley grain, and urea; barley straw and maize grain; barley straw, maize grain, and urea, or maize grain.

D6-34 New methods for using straw in feed. Laczynski, B. Przem. Ferment. Rolny. 20(4): 14-17. (1976) Chem. Abs. 85 076383

A review with 25 references on the use of straw in the manufacture of mixed feeds and premixes.

D6-35 Utilization of distillation wastes for animal feeding. Mordenti, A., Zaghini, G. (First Aliment. Anim., Univ. Bologna, Bolgna, Italy) Tec. Molitoria 26(2): 102-109. (1975) Chem. Abs. 83 094914

A review with 10 references.

D6-36 Wood cellulose as an energy source in lamb fattening rations. Riquelme, E., Dyer, I. A., Baribo, L. E., Couch, B. Y. J. Anim. Sci. 40(5): 977-981. (1975)

Two finishing studies were conducted to determine the value of wood cellulose as an energy source in lamb-fattening rations and to evaluate the effect of feeding high levels of cellulose fiber on performance and carcass traits of finishing lambs.

D6-37 Research on the utilization of cellulolytic enzymes in the nutrition of fattening cattle. Palenik, S., Mechir, M. Ved. Pr. Vysk, Ust. Zivocisnej Vyroby nites 7: 141-154. (1970) Biol. Abs. 55 011887

The addition of cellulolytic enzyme preparations into feed rations of fattening cattle did not raise growth intensity nor did it improve feed utilization. Enzyme preparations had no effect on the carcass value and the quality of the meat of fattening steers.

D6-38 Studies on the utilization of rice straw: Part 2. Digestion trials on silage of high moisture rice straw with wethers. Toyokawa, K., Takayasu, I. Bul. Faculty Agr. Hirosaki Univ. 17: 81-85. (1971) Biol. Abs. 54 023536

Wethers were used to study the palatability and digestibility of silage made from high-moisture rice straw threshed immediately after cutting. The data were compared with that from ordinary air-dried rice straw from the same field.

D6-39 Rye grass straw utilization by sheep. Anderson, D., Ralston, A. T. J. Anim. Sci. 36(6): 1210. (1973)

Complete balanced rations containing 74.5% ryegrass straw were fed to sheep. NaOH-treated straw was superior to untreated.

D6-40 Rice bran composition and digestibility by the pig. Brooks, C. C., Lumanta, I. G., Jr. J. Anim. Sci. 41(1): 308. (1975)

Rice bran was analyzed chemically and in digestion trials in pigs.

D6-41 Hemicellulose product vs. cane molasses for lambs. Cantner, E. W., Wilson, W. M., Hall, G. A. B., Hatfield, E. E. J. Anim. Sci. 35(1): 227. (1972)

Increasing levels of dietary hemicellulose improved average daily gains of lambs.

D6-42 Feeding value of low lignin corn silage. Colenbrander, V. F., Lechtenberg, V. L., Bauman, L. F. J. Anim. Sci. 41(1): 332-333. (1975)
Brown midrib corn gave higher daily gain and feed intake in feeding trails on heifers.

D6-43 Digestion of plant cell walls by animals. Fonnesbeck, P. V., Harris, L. E., Kearl, L. C. J. Anim. Sci. 39(1): 182. (1974)
The digestibility of plant cell wall constituents was compared for sheep, rabbits, swine, rats, and chickens. Cellulose and hemicellulose are partially digested by rats and swine.

D6-44 Nutritional value of grain sorghum residues. Perry, L. J., Jr., Smith, D. H., Rehm, G. J. Anim. Sci. 41(1): 338. (1975)
Grain sorghum residues were chemically analyzed.

D6-45 Use of wood cellulose fiber in lamb fattening rations. Riquelme, E., Dyer, I. A. J. Anim. Sci. 38(6): 1344. (1974)
Daily gain by lambs on 66% wood cellulose was the same as that gained by lambs on the control diet. Results indicate that wood cellulose fiber can be fed at high levels without affecting U S D A carcass grade of lambs.

D6-46 Ruminant feeds from treated fibrous wastes. Ronning, D., Kamstra, L. D. J. Anim. Sci. 42(5): 1366. (1976)
Peracetic acid was used to treat ponderosa pine wastes to improve their value as feed.

D6-47 Feeding grass straws to wintering cows. Vavra, M., Phillips, R. L., McArthur, J. A. B. J. Anim. Sci. 41(1): 424. (1975)
Merion bluegrass and hard fescue straws were fed to pregnant cows. Three of 20 hard fescue cows died of abomasal compaction.

D6-48 Manure feed ingredient, cattle. Fisher, L. J. Agrologist 4(3): 19-20. (1975)
Feedlot waste must be modified before feeding. Poultry manure will make a good N source for ruminants.

D6-49 Evaluation of wheat straw in feeder lamb rations. Hackett, M. R., Hillers, J. K., Kromann, R. P., Martin, E. L. Proc. West. Sect. Amer. Soc. Anim. Sci. 26: 143-145. (1975)
The performance of lambs fed different levels of wheat straw was studied. Another experiment was conducted to evaluate consumption of an all-roughage ration fed in different physical forms as dust suppressants.

D6-50 Feeding value of potato protein manufactured from potato starch industry by-products. Oohara, H., Furuya, M., Oohara, Y., Kojima, N. Res. Bul. Obihiro Zootech. Univ. Ser. 1 6(1): 68-73. (1969) Biol. Abs. 51 056198
Studied the feeding value of potato protein manufactured from by-products of the potato starch industry by a special extraction method.

D6-51 Feeding grass straws to cattle and horses. Vough, L. R., Adams, H. P., Youngberg, H. W. (Oreg. State Univ. Ext. Serv.) Fact Sheet Oreg. State Univ. Ext. Serv. 234, 2 pp. (1976)

Grass straw, properly handled and supplemented, will maintain dry cows and mature horses and help lower food costs without injury to the stock.

D6-52 The nutritive value for ruminants of a complete processed diet based on barley straw. Wainman, F. W., Blaxter, K. L., Pullar, J. D. J. Agr. Sci. 74(2): 311-314. (1970)

Calorimetric experiments were made on a complete extruded diet for ruminants; Ruminant Diet A prepared by Messrs. U. K. Compound Feeds, Ltd. Twelve determinations of energy and N retention were made by using sheep.

D6-53 Level and form of rice straw rations. White, T. W., Reynolds, W. L., Hembry, F. G. J. Anim. Sci. 33(6): 1365-1370. (1971)

Two feedlot trials were conducted to study the performance of steers fed rations containing different levels, forms, and grinding-screen size of rice straw.

D6-54 Evaluation of forages with prairie voles *Microtus ochrogaster*. Hill, J. G., Stiles, D. A., Lee, D. D., Jr. J. Dairy Sci. 55(5): 702. (1972)

Voles were fed four forages: Alfalfa, tall fescue, brome grass, and orchard grass at 50 and 75% levels. Their were no significant differences at the 50% level. Voles could survive at 40.4% cell walls; they died at 45.4% cell walls in their diets.

D6-55 Goose feeding and cellulose digestion. Mattocks, J. G. Wildfowl 22: 107-113. (1971)

Literature, anatomical, and experimental studies failed to show that geese digest cellulose.

D6-56 Crop residues straw, corn stover, feed. Mowat, D. N. Agrologist 4(3): 18-19. (1975)

Alkali treatments to improve crop residues for feed are discussed. The article is popular.

D6-57 Wood II. Waste products, feed. Nicholson, J. W. G. Agrologist 4(3): 17. (1975)

This popular article lists woods and wood byproducts that are digestible by ruminants.

D6-58 Wood. Bender, F. Agrologist 4(3): 16. (1975)

This popular article explains why wood is not digestible in its native state and how it can be treated to make it more digestible.

D6-59 Cellulose digestion in sheep fed an extract of *Aspergillus oryzae*. Niver, J. W., Tucker, R. E., Mitchell, G. E., Jr. Ky. Agr. Expt. Sta. Prog. Rpt. 196, p. 59. (1971)

A. oryzae extract did not improve fiber digestibility by sheep.

D6-60 Utilization of ligno cellulose by ruminants. Pigden, W. J., Bender, F. World Anim. Rev. 4: 7-10. (1972)

This article discusses the reason for the low digestibility of lignocellulose by ruminants and how it might be improved.

D6-61 Supplements to oat straw for sheep. Rice, R. W. J. Anim. Sci. 35(1): 233. (1972)

Oat straw was supplemented with soybean meal; soybean meal and sulfur; and soybean meal, molasses and urea. All supplements improved N balance and feed intake over unsupplemented oat straw.

D6-62 Feeding grass straws to wintering cows. Vavra, M., Phillips, R. L., McArthur, J. A. B. Proc. West. Sect. Amer. Soc. Anim. Sci. 26: 137-139. (1975)

This study evaluated hard fescue and Merion bluegrass straws for feeding to cows.

D6-63 Broiler litter as a wintering feed for beef cows and heifers. Webb, K. E., Jr., Fontenot, J. P., McClure, W. H. Res. Div. Rpt. Va. Polytech. Inst. and State Univ. Res. Div. 158: 125-128. (1974)

Broiler litter will sustain ruminants satisfactorily but the $CuSO_4$ that was fed to the chickens and remains in the litter causes Cu toxicity if fed to sheep.

D6-64 Coarse barley straw in dairy rations containing alfalfa hay cubes digestibility. Whiting, F. M., Brown, W. H., Stull, J. W. J. Dairy Sci. 59 (4): 764-766. (1976)

Four-percent coarse barley straw was substituted for an equal weight of alfalfa cubes for dairy cows. Authors think a relatively small amount of coarse roughage can be added to increase digestibility without reducing feed intake for cows.

D6-65 Food and energy from cellulosic waste. Babbar, I. J. Chem. Age India 26(7): 505-511. (1975) Chem. Abs. 84 126399

The conversion of cellulosic wastes to food and fuel is reviewed. Includes 72 references.

D6-66 Utilization of legumes in poultry feeding. Cuca, G. M., Jaffe, W. G. (ed.) Nutritional Aspects of Common Beans and Other Legume Seeds as Animal and Human Foods Symposium. Archivos Latinoamericanos de Nutricion: Caracas, Venezuela, pp. 27-40. (1975) Chem. Abs. 84 29626

A series of experiments were conducted to study the nutritive value of garbanzo beans, broad beans, lentils, and *Clitora ternatea* for poultry.

D6-67 Study on the feeding of mint distillery meal to dairy cattle. Furuya, M., Oohara, H., Kojima, N. Res. Bul. Obihiro Zootech. Univ. Ser. 1 5(4): 617-628. (1968)

A distilled byproduct of the mint crop is used for conventional feeding of horses, sheep, and other livestock in the Kitami district of Hokkaido. Investigated the digestibility and effect on the yield and the chemical composition of milk by feeding it in pelleted form.

D6-68 Modified wood waste and straw as components of animal feeds. Hartley, R. D., King, N. J. J. Sci. Food Agr. 24(4): 495. (1973)

Sawdust or straw was treated with *Fomes lividus* and then with NaOH in aqueous solution.

D6-69 Feeding poultry litter to ruminants. Jacobs, G. J. L. Proc. Austral. Soc. Anim. Prod. 11: 417-420. (1976)

Poultry litter was found to be unsuitable for 6- to 12-week-old calves, but it was possible to feed more than 30% poultry litter to 12- to 18-week-old calves at a considerable savings in cost.

D6-70 Intake of diets varying in protein and cellulose. Jones, G. M., Cecyre, A., Gaudreau, J-M. J. Anim. Sci. 31(5): 1040. (1970)

Sheep were fed diets varying in crude protein level and cellulose level. N retention was lowest at the lowest protein level.

D6-71 Carboniferous plants as animal food. Barnard, P. D. W. Biol. J. Linn. Soc. 6(4): 372. (1974)

The food not available to the animals during the Upper Carboniferous period, mainly cellulose, was fossilized.

D6-72 Use of a sugarcane derived feedstuff for livestock. Donefer, E., James, L. A., Laurie, C. K. Reid, R. L. (ed.) Proceedings of the III World Conference on Animal Production. Sidney Univ. Press, Sidney, Australia, pp. 563-566. (1975)

The feedstuff resulting from rind separation of sugarcane was successfully fed to cattle, sheep, swine, and poultry.

D6-73 Agricultural by-products as supplemental feed for crawfish. Goyert, J. C., Avault, J. W., Jr., Rutledge, J. E., Hernandez, T. P. (La. Agr. Expt. Sta.) La. Agr. 19(2): 10-11. (1975)

This study was undertaken to determine how well agricultural by-products would serve as food sources for crawfish culture.

II. TECHNICAL ABBREVIATIONS

atm	- atmosphere
BOD	- biological oxidation demand
BTU	- B.t.u. = British thermal unit
C	- carbon
C	- Celsius
Ca	- calcium
CCC	- chlorocholine chloride
CHO	- carbohydrate
Cl	- chlorine
Co	- cobalt
CO	- carbon monoxide
COD	- chemical oxidation demand
CSM	- cell soluble matter
Cu	- copper
d	- dyne
DM	- dry matter
EtOH	- ethyl alcohol
F	- Fahrenheit
Fe	- iron
ft	- foot
g	- gram
gal	- gallon
H_2O_2	- hydrogen peroxide
H_2SO_4	- sulfuric acid
H_3PO_4	- phosphoric acid
HCl	- hydrochloric acid
He	- helium
HNO_3	- nitric acid
HOAc	- acetic acid
IVRD	- *in vitro* rumen digestibility
K	- potassium
kcal	- kilocalorie
kg	- kilogram
kg/T	- kilograms per ton
m	- meter
M	- molar
Meq	- millequivalent
mg	- milligram
min	- minute
ml	- milliliter
mm	- millimeter
Mn	- manganese
mo	- month
Mo	- molybdenum
MWL	- milled wood lignin
N	- nitrogen
Na	- sodium
NaClO	- sodium hypochlorite
NDF	- neutral detergent fiber
NH_3	- ammonia
Ni	- nickel
nm	- nanometer
NPN	- nonprotein nitrogen
O_2	- oxygen
OH	- hydroxide
P	- phosphorous
Pb	- lead
pH	- hydrogen-ion concentration
ppm	- parts per million
psi	- p.s.i. = pounds per square inch
RNA	- ribonucleic acid
S	- sulfur
SCP	- single cell protein
SiC	- silicon carbide
SO_2	- sulfur dioxide
TDN	- total digestible nutrients
UV	- ultra violet
var.	- variant
VFA	- volatile fatty acids
vol	- volume
W	- tungsten
w/w	- weight per weight
Zn	- zinc

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